APPENDIX I

REFERENCES USED TO DEVELOP THE TRAMAN

NOTE: The following references were current at the time this TRAMAN was published, but you should be sure you have the current edition.

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APPENDIX II

USEFUL TABLES

Table AII-1.—Natural Sines and Cosines

MIN	0°		1°		2°		3°		4°		
	SIN	COS	SIN	COS	SIN	COS	SIN	COS	SIN	COS	
0	0000000	1.00000	0.01745	0.99985	0.03490	0.99939	0.05234	0.99863	0.06976	0.99756	60
1	0.00029	1.00000	0.01774	0.99984	0.03519	0.99938	0.05263	0.99861	0.07005	0.99754	59
2	0.00058	1.00000	0.01803	0.99984	0.03548	0.99937	0.05292	0.99860	0.07034	0.99752	58
3	0.00087	1.00000	0.01832	0.99983	0.03577	0.99936	0.05321	0.99858	0.07063	0.99750	57
4	0.00116	1.00000	0.01862	0.99983	0.03606	0.99935	0.05350	0.99857	0.07092	0.99748	56
5	0.00145	1.00000	0.01891	0.99982	0.03635	0.99934	0.05379	0.99855	0.07121	0.99746	55
6	0.00175	1.00000	0.01920	0.99982	0.03664	0.99933	0.05408	0.99854	0.07150	0.99744	54
7	0.00204	1.00000	0.01949	0.99981	0.03693	0.99932	0.05437	0.99852	0.07179	0.99742	53
8	0.00233	1.00000	0.01978	0.99980	0.03723	0.99931	0.05466	0.99851	0.07208	0.99740	52
9	0.00262	1.00000	0.02007	0.99980	0.03752	0.99930	0.05495	0.99849	0.07237	0.99738	51
10	0.00291	1.00000	0.02036	0.99979	0.03781	0.99929	0.05524	0.99847	0.07266	0.99736	50
11	0.00320	0.99999	0.02065	0.99979	0.03810	0.99927	0.05553	0.99846	0.07295	0.99734	49
12	0.00349	0.99999	0.02094	0.99978	0.03839	0.99926	0.05582	0.99844	0.07324	0.99731	48
13	0.00378	0.99999	0.02123	0.99977	0.03868	0.99925	0.05611	0.99842	0.07353	0.99729	47
14	0.00407	0.99999	0.02152	0.99977	0.03897	0.99924	0.05640	0.99841	0.07382	0.99727	46
15	0.00436	0.99999	0.02181	0.99976	0.03926	0.99923	0.05669	0.99839	0.07411	0.99725	45
16	0.00465	0.99999	0.02211	0.99976	0.03955	0.99922	0.05698	0.99838	0.07440	0.99723	44
17	0.00495	0.99999	0.02240	0.99975	0.03984	0.99921	0.05727	0.99836	0.07469	0.99721	43
18	0.00524	0.99999	0.02269	0.99974	0.04013	0.99919	0.05756	0.99834	0.07498	0.99719	42
19	0.00553	0.99998	0.02298	0.99974	0.04042	0.99918	0.05785	0.99833	0.07527	0.99716	41
20	0.00582	0.99998	0.02327	0.99973	0.04071	0.99917	0.05814	0.99831	0.07556	0.99714	40
21	0.00611	0.99998	0.02356	0.99972	0.04100	0.99916	0.05844	0.99829	0.07585	0.99712	39
22	0.00640	0.99998	0.02385	0.99972	0.04129	0.99915	0.05873	0.99827	0.07614	0.99710	38
23	0.00669	0.99998	0.02414	0.99971	0.04159	0.99913	0.05902	0.99826	0.07643	0.99708	37
24	0.00698	0.99998	0.02443	0.99970	0.04188	0.99912	0.05931	0.99824	0.07672	0.99705	36
25	0.00727	0.99997	0.02472	0.99969	0.04217	0.99911	0.05960	0.99822	0.07701	0.99703	35
26	0.00756	0.99997	0.02501	0.99969	0.04246	0.99910	0.05989	0.99821	0.07730	0.99701	34
27	0.00785	0.99997	0.02530	0.99968	0.04275	0.99909	0.06018	0.99819	0.07759	0.99699	33
28	0.00814	0.99997	0.02560	0.99967	0.04304	0.99907	0.06047	0.99817	0.07788	0.99696	32
29	0.00844	0.99996	0.02589	0.99966	0.04333	0.99906	0.06076	0.99815	0.07817	0.99694	31
30	0.00873	0.99996	0.02618	0.99966	0.04362	0.99905	0.06105	0.99813	0.07846	0.99692	30
31	0.00902	0.99996	0.02647	0.99965	0.04391	0.99904	0.06134	0.99812	0.07875	0.99689	29
32	0.00931	0.99996	0.02676	0.99964	0.04420	0.99902	0.06163	0.99810	0.07904	0.99687	28
33	0.00960	0.99995	0.02705	0.99963	0.04449	0.99901	0.06192	0.99808	0.07933	0.99685	27
34	0.00989	0.99995	0.02734	0.99963	0.04478	0.99900	0.06221	0.99806	0.07962	0.99683	26
35	0.01018	0.99995	0.02763	0.99962	0.04507	0.99898	0.06250	0.99804	0.07991	0.99680	25
36	0.01047	0.99995	0.02792	0.99961	0.04536	0.99897	0.06279	0.99803	0.08020	0.99678	24
37	0.01076	0.99994	0.02821	0.99960	0.04565	0.99896	0.06308	0.99801	0.08049	0.99676	23
38	0.01105	0.99994	0.02850	0.99959	0.04594	0.99894	0.06337	0.99799	0.08078	0.99673	22
39	0.01134	0.99994	0.02879	0.99959	0.04623	0.99893	0.06366	0.99797	0.08107	0.99671	21
40	0.01164	0.99993	0.02908	0.99958	0.04653	0.99892	0.06395	0.99795	0.08136	0.99668	20
41	0.01193	0.99993	0.02938	0.99957	0.04682	0.99890	0.06424	0.99793	0.08165	0.99666	19
42	0.01222	0.99993	0.02967	0.99956	0.04711	0.99889	0.06453	0.99792	0.08194	0.99664	18
43	0.01251	0.99992	0.02996	0.99955	0.04740	0.99888	0.06482	0.99790	0.08223	0.99661	17
44	0.01280	0.99992	0.03025	0.99954	0.04769	0.99886	0.06511	0.99788	0.08252	0.99659	16
45	0.01309	0.99991	0.03054	0.99953	0.04798	0.99885	0.06540	0.99786	0.08281	0.99657	15
46	0.01338	0.99991	0.03083	0.99952	0.04827	0.99883	0.06569	0.99784	0.08310	0.99654	14
47	0.01367	0.99991	0.03112	0.99952	0.04856	0.99882	0.06598	0.99782	0.08339	0.99652	13
48	0.01396	0.99990	0.03141	0.99951	0.04885	0.99881	0.06627	0.99780	0.08368	0.99649	12
49	0.01425	0.99990	0.03170	0.99950	0.04914	0.99879	0.06656	0.99778	0.08397	0.99647	11
50	0.01454	0.99989	0.03199	0.99949	0.04943	0.99878	0.06685	0.99776	0.08426	0.99644	10
51	0.01483	0.99989	0.03228	0.99948	0.04972	0.99876	0.06714	0.99774	0.08455	0.99642	9
52	0.01513	0.99989	0.03257	0.99947	0.05001	0.99875	0.06743	0.99772	0.08484	0.99639	8
53	0.01542	0.99988	0.03286	0.99946	0.05030	0.99873	0.06773	0.99770	0.08513	0.99637	7
54	0.01571	0.99988	0.03316	0.99945	0.05059	0.99872	0.06802	0.99768	0.08542	0.99635	6
55	0.01600	0.99987	0.03345	0.99944	0.05088	0.99870	0.06831	0.99766	0.08571	0.99632	5
56	0.01629	0.99987	0.03374	0.99943	0.05117	0.99869	0.06860	0.99764	0.08600	0.99630	4
57	0.01658	0.99986	0.03403	0.99942	0.05146	0.99867	0.06889	0.99762	0.08629	0.99627	3
58	0.01687	0.99986	0.03432	0.99941	0.05175	0.99866	0.06918	0.99760	0.08658	0.99625	2
59	0.01716	0.99985	0.03461	0.99940	0.05205	0.99864	0.06947	0.99758	0.08687	0.99622	1
60	0.01745	0.99985	0.03490	0.99939	0.05234	0.99863	0.06976	0.99756	0.08716	0.99619	0
	COS	SIN	COS	SIN	COS	SIN	COS	SIN	COS	SIN	MIN
	89°		88°		87°		86°		85°		

MIN	5° SIN	5° COS	6° SIN	6° COS	7° SIN	7° COS	8° SIN	8° COS	9° SIN	9° COS	
0	0.08716	0.99619	0.10453	0.99452	0.12187	0.99255	0.13917	0.99027	0.15643	0.98769	60
1	0.08745	0.99617	0.10482	0.99449	0.12216	0.99251	0.13946	0.99023	0.15672	0.98764	59
2	0.08774	0.99614	0.10511	0.99446	0.12245	0.99248	0.13975	0.99019	0.15701	0.98760	58
3	0.08803	0.99612	0.10540	0.99443	0.12274	0.99244	0.14004	0.99015	0.15730	0.98755	57
4	0.08831	0.99609	0.10569	0.99440	0.12302	0.99240	0.14033	0.99011	0.15758	0.98751	56
5	0.08860	0.99607	0.10597	0.99437	0.12331	0.99237	0.14061	0.99006	0.15787	0.98746	55
6	0.08889	0.99604	0.10626	0.99434	0.12360	0.99233	0.14090	0.99002	0.15816	0.98741	54
7	0.08918	0.99602	0.10655	0.99431	0.12389	0.99230	0.14119	0.98998	0.15845	0.98737	53
8	0.08947	0.99599	0.10684	0.99428	0.12418	0.99226	0.14148	0.98994	0.15873	0.98732	52
9	0.08976	0.99596	0.10713	0.99424	0.12447	0.99222	0.14177	0.98990	0.15902	0.98728	51
10	0.09005	0.99594	0.10742	0.99421	0.12476	0.99219	0.14205	0.98986	0.15931	0.98723	50
11	0.09034	0.99591	0.10771	0.99418	0.12504	0.99215	0.14234	0.98982	0.15959	0.98718	49
12	0.09063	0.99588	0.10800	0.99415	0.12533	0.99211	0.14263	0.98978	0.15988	0.98714	48
13	0.09092	0.99586	0.10829	0.99412	0.12562	0.99208	0.14292	0.98973	0.16017	0.98709	47
14	0.09121	0.99583	0.10858	0.99409	0.12591	0.99204	0.14320	0.98969	0.16046	0.98704	46
15	0.09150	0.99580	0.10887	0.99406	0.12620	0.99200	0.14349	0.98965	0.16074	0.98700	45
16	0.09179	0.99578	0.10916	0.99402	0.12649	0.99197	0.14378	0.98961	0.16103	0.98695	44
17	0.09208	0.99575	0.10945	0.99399	0.12678	0.99193	0.14407	0.98957	0.16132	0.98690	43
18	0.09237	0.99572	0.10973	0.99396	0.12706	0.99189	0.14436	0.98953	0.16160	0.98686	42
19	0.09266	0.99570	0.11002	0.99393	0.12735	0.99186	0.14464	0.98948	0.16189	0.98681	41
20	0.09295	0.99567	0.11031	0.99390	0.12764	0.99182	0.14493	0.98944	0.16218	0.98676	40
21	0.09324	0.99564	0.11060	0.99386	0.12793	0.99178	0.14522	0.98940	0.16246	0.98671	39
22	0.09353	0.99562	0.11089	0.99383	0.12822	0.99175	0.14551	0.98936	0.16275	0.98667	38
23	0.09382	0.99559	0.11118	0.99380	0.12851	0.99171	0.14580	0.98931	0.16304	0.98662	37
24	0.09411	0.99556	0.11147	0.99377	0.12880	0.99167	0.14608	0.98927	0.16333	0.98657	36
25	0.09440	0.99553	0.11176	0.99374	0.12908	0.99163	0.14637	0.98923	0.16361	0.98652	35
26	0.09469	0.99551	0.11205	0.99370	0.12937	0.99160	0.14666	0.98919	0.16390	0.98648	34
27	0.09498	0.99548	0.11234	0.99367	0.12966	0.99156	0.14695	0.98914	0.16419	0.98643	33
28	0.09527	0.99545	0.11263	0.99364	0.12995	0.99152	0.14723	0.98910	0.16447	0.98638	32
29	0.09556	0.99542	0.11291	0.99360	0.13024	0.99148	0.14752	0.98906	0.16476	0.98633	31
30	0.09585	0.99540	0.11320	0.99357	0.13053	0.99144	0.14781	0.98902	0.16505	0.98629	30
31	0.09614	0.99537	0.11349	0.99354	0.13081	0.99141	0.14810	0.98897	0.16533	0.98624	29
32	0.09642	0.99534	0.11378	0.99351	0.13110	0.99137	0.14838	0.98893	0.16562	0.98619	28
33	0.09671	0.99531	0.11407	0.99347	0.13139	0.99133	0.14867	0.98889	0.16591	0.98614	27
34	0.09700	0.99528	0.11436	0.99344	0.13168	0.99129	0.14896	0.98884	0.16620	0.98609	26
35	0.09729	0.99526	0.11465	0.99341	0.13197	0.99125	0.14925	0.98880	0.16648	0.98604	25
36	0.09758	0.99523	0.11494	0.99337	0.13226	0.99122	0.14954	0.98876	0.16677	0.98600	24
37	0.09787	0.99520	0.11523	0.99334	0.13254	0.99118	0.14982	0.98871	0.16706	0.98595	23
38	0.09816	0.99517	0.11552	0.99331	0.13283	0.99114	0.15011	0.98867	0.16734	0.98590	22
39	0.09845	0.99514	0.11580	0.99327	0.13312	0.99110	0.15040	0.98863	0.16763	0.98585	21
40	0.09874	0.99511	0.11609	0.99324	0.13341	0.99106	0.15069	0.98858	0.16792	0.98580	20
41	0.09903	0.99508	0.11638	0.99320	0.13370	0.99102	0.15097	0.98854	0.16820	0.98575	19
42	0.09932	0.99506	0.11667	0.99317	0.13399	0.99098	0.15126	0.98849	0.16849	0.98570	18
43	0.09961	0.99503	0.11696	0.99314	0.13427	0.99094	0.15155	0.98845	0.16878	0.98565	17
44	0.09990	0.99500	0.11725	0.99310	0.13456	0.99091	0.15184	0.98841	0.16906	0.98561	16
45	0.10019	0.99497	0.11754	0.99307	0.13485	0.99087	0.15212	0.98836	0.16935	0.98556	15
46	0.10048	0.99494	0.11783	0.99303	0.13514	0.99083	0.15241	0.98832	0.16964	0.98551	14
47	0.10077	0.99491	0.11812	0.99300	0.13543	0.99079	0.15270	0.98827	0.16992	0.98546	13
48	0.10106	0.99488	0.11840	0.99297	0.13572	0.99075	0.15299	0.98823	0.17021	0.98541	12
49	0.10135	0.99485	0.11869	0.99293	0.13600	0.99071	0.15327	0.98818	0.17050	0.98536	11
50	0.10164	0.99482	0.11898	0.99290	0.13629	0.99067	0.15356	0.98814	0.17078	0.98531	10
51	0.10192	0.99479	0.11927	0.99286	0.13658	0.99063	0.15385	0.98809	0.17107	0.98526	9
52	0.10221	0.99476	0.11956	0.99283	0.13687	0.99059	0.15414	0.98805	0.17136	0.98521	8
53	0.10250	0.99473	0.11985	0.99279	0.13716	0.99055	0.15442	0.98800	0.17164	0.98516	7
54	0.10279	0.99470	0.12014	0.99276	0.13744	0.99051	0.15471	0.98796	0.17193	0.98511	6
55	0.10308	0.99467	0.12043	0.99272	0.13773	0.99047	0.15500	0.98791	0.17222	0.98506	5
56	0.10337	0.99464	0.12071	0.99269	0.13802	0.99043	0.15529	0.98787	0.17250	0.98501	4
57	0.10366	0.99461	0.12100	0.99265	0.13831	0.99039	0.15557	0.98782	0.17279	0.98496	3
58	0.10395	0.99458	0.12129	0.99262	0.13860	0.99035	0.15586	0.98778	0.17308	0.98491	2
59	0.10424	0.99455	0.12158	0.99258	0.13889	0.99031	0.15615	0.98773	0.17336	0.98486	1
60	0.10453	0.99452	0.12187	0.99255	0.13917	0.99027	0.15643	0.98769	0.17365	0.98481	0
	COS	SIN	COS	SIN	COS	SIN	COS	SIN	COS	SIN	MIN
	84°		83°		82°		81°		80°		

Table AII-1.—Natural Sines and Cosines—Continued

MIN	10°		11°		12°		13°		14°		
	SIN	COS	SIN	COS	SIN	COS	SIN	COS	SIN	COS	
0	0.17365	0.98481	0.19081	0.98163	0.20791	0.97815	0.22495	0.97437	0.24192	0.97030	60
1	0.17393	0.98476	0.19109	0.98157	0.20820	0.97809	0.22523	0.97430	0.24220	0.97023	59
2	0.17422	0.98471	0.19138	0.98152	0.20848	0.97803	0.22552	0.97424	0.24249	0.97015	58
3	0.17451	0.98466	0.19167	0.98146	0.20877	0.97797	0.22580	0.97417	0.24277	0.97008	57
4	0.17479	0.98461	0.19195	0.98140	0.20905	0.97791	0.22608	0.97411	0.24305	0.97001	56
5	0.17508	0.98455	0.19224	0.98135	0.20933	0.97784	0.22637	0.97404	0.24333	0.96994	55
6	0.17537	0.98450	0.19252	0.98129	0.20962	0.97778	0.22665	0.97398	0.24362	0.96987	54
7	0.17565	0.98445	0.19281	0.98124	0.20990	0.97772	0.22693	0.97391	0.24390	0.96980	53
8	0.17594	0.98440	0.19309	0.98118	0.21019	0.97766	0.22722	0.97384	0.24418	0.96973	52
9	0.17623	0.98435	0.19338	0.98112	0.21047	0.97760	0.22750	0.97378	0.24446	0.96966	51
10	0.17651	0.98430	0.19366	0.98107	0.21076	0.97754	0.22778	0.97371	0.24474	0.96959	50
11	0.17680	0.98425	0.19395	0.98101	0.21104	0.97748	0.22807	0.97365	0.24503	0.96952	49
12	0.17708	0.98420	0.19423	0.98096	0.21132	0.97742	0.22835	0.97358	0.24531	0.96945	48
13	0.17737	0.98414	0.19452	0.98090	0.21161	0.97735	0.22863	0.97351	0.24559	0.96937	47
14	0.17766	0.98409	0.19481	0.98084	0.21189	0.97729	0.22892	0.97345	0.24587	0.96930	46
15	0.17794	0.98404	0.19509	0.98079	0.21218	0.97723	0.22920	0.97338	0.24615	0.96923	45
16	0.17823	0.98399	0.19538	0.98073	0.21246	0.97717	0.22948	0.97331	0.24644	0.96916	44
17	0.17852	0.98394	0.19566	0.98067	0.21275	0.97711	0.22977	0.97325	0.24672	0.96909	43
18	0.17880	0.98389	0.19595	0.98061	0.21303	0.97705	0.23005	0.97318	0.24700	0.96902	42
19	0.17909	0.98383	0.19623	0.98056	0.21331	0.97698	0.23033	0.97311	0.24728	0.96894	41
20	0.17937	0.98378	0.19652	0.98050	0.21360	0.97692	0.23062	0.97304	0.24756	0.96887	40
21	0.17966	0.98373	0.19680	0.98044	0.21388	0.97686	0.23090	0.97298	0.24784	0.96880	39
22	0.17995	0.98368	0.19709	0.98039	0.21417	0.97680	0.23118	0.97291	0.24813	0.96873	38
23	0.18023	0.98362	0.19737	0.98033	0.21445	0.97673	0.23146	0.97284	0.24841	0.96866	37
24	0.18052	0.98357	0.19766	0.98027	0.21474	0.97667	0.23175	0.97278	0.24869	0.96858	36
25	0.18081	0.98352	0.19794	0.98021	0.21502	0.97661	0.23203	0.97271	0.24897	0.96851	35
26	0.18109	0.98347	0.19823	0.98016	0.21530	0.97655	0.23231	0.97264	0.24925	0.96844	34
27	0.18138	0.98341	0.19851	0.98010	0.21559	0.97648	0.23260	0.97257	0.24954	0.96837	33
28	0.18166	0.98336	0.19880	0.98004	0.21587	0.97642	0.23288	0.97251	0.24982	0.96829	32
29	0.18195	0.98331	0.19908	0.97998	0.21616	0.97636	0.23316	0.97244	0.25010	0.96822	31
30	0.18224	0.98325	0.19937	0.97992	0.21644	0.97630	0.23345	0.97237	0.25038	0.96815	30
31	0.18252	0.98320	0.19965	0.97987	0.21672	0.97623	0.23373	0.97230	0.25066	0.96807	29
32	0.18281	0.98315	0.19994	0.97981	0.21701	0.97617	0.23401	0.97223	0.25094	0.96800	28
33	0.18309	0.98310	0.20022	0.97975	0.21729	0.97611	0.23429	0.97217	0.25122	0.96793	27
34	0.18338	0.98304	0.20051	0.97969	0.21758	0.97604	0.23458	0.97210	0.25151	0.96786	26
35	0.18367	0.98299	0.20079	0.97963	0.21786	0.97598	0.23486	0.97203	0.25179	0.96778	25
36	0.18395	0.98294	0.20108	0.97958	0.21814	0.97592	0.23514	0.97196	0.25207	0.96771	24
37	0.18424	0.98288	0.20136	0.97952	0.21843	0.97585	0.23542	0.97189	0.25235	0.96764	23
38	0.18452	0.98283	0.20165	0.97946	0.21871	0.97579	0.23571	0.97182	0.25263	0.96756	22
39	0.18481	0.98277	0.20193	0.97940	0.21899	0.97573	0.23599	0.97176	0.25291	0.96749	21
40	0.18509	0.98272	0.20222	0.97934	0.21928	0.97566	0.23627	0.97169	0.25320	0.96742	20
41	0.18538	0.98267	0.20250	0.97928	0.21956	0.97560	0.23656	0.97162	0.25348	0.96734	19
42	0.18567	0.98261	0.20279	0.97922	0.21985	0.97553	0.23684	0.97155	0.25376	0.96727	18
43	0.18595	0.98256	0.20307	0.97916	0.22013	0.97547	0.23712	0.97148	0.25404	0.96719	17
44	0.18624	0.98250	0.20336	0.97910	0.22041	0.97541	0.23740	0.97141	0.25432	0.96712	16
45	0.18652	0.98245	0.20364	0.97905	0.22070	0.97534	0.23769	0.97134	0.25460	0.96705	15
46	0.18681	0.98240	0.20393	0.97899	0.22098	0.97528	0.23797	0.97127	0.25488	0.96697	14
47	0.18710	0.98234	0.20421	0.97893	0.22126	0.97521	0.23825	0.97120	0.25516	0.96690	13
48	0.18738	0.98229	0.20450	0.97887	0.22155	0.97515	0.23853	0.97113	0.25545	0.96682	12
49	0.18767	0.98223	0.20478	0.97881	0.22183	0.97508	0.23882	0.97106	0.25573	0.96675	11
50	0.18795	0.98218	0.20507	0.97875	0.22212	0.97502	0.23910	0.97100	0.25601	0.96667	10
51	0.18824	0.98212	0.20535	0.97869	0.22240	0.97496	0.23938	0.97093	0.25629	0.96660	9
52	0.18852	0.98207	0.20563	0.97863	0.22268	0.97489	0.23966	0.97086	0.25657	0.96653	8
53	0.18881	0.98201	0.20592	0.97857	0.22297	0.97483	0.23995	0.97079	0.25685	0.96645	7
54	0.18910	0.98196	0.20620	0.97851	0.22325	0.97476	0.24023	0.97072	0.25713	0.96638	6
55	0.18938	0.98190	0.20649	0.97845	0.22353	0.97470	0.24051	0.97065	0.25741	0.96630	5
56	0.18967	0.98185	0.20677	0.97839	0.22382	0.97463	0.24079	0.97058	0.25769	0.96623	4
57	0.18995	0.98179	0.20706	0.97833	0.22410	0.97457	0.24108	0.97051	0.25798	0.96615	3
58	0.19024	0.98174	0.20734	0.97827	0.22438	0.97450	0.24136	0.97044	0.25826	0.96608	2
59	0.19052	0.98168	0.20763	0.97821	0.22467	0.97444	0.24164	0.97037	0.25854	0.96600	1
60	0.19081	0.98163	0.20791	0.97815	0.22495	0.97437	0.24192	0.97030	0.25882	0.96593	0
	COS	SIN	COS	SIN	COS	SIN	COS	SIN	COS	SIN	MIN
	79°		78°		77°		76°		75°		

Table AII-1.—Natural Sines and Cosines—Continued

MIN	15°		16°		17°		18°		19°		
	SIN	COS	SIN	COS	SIN	COS	SIN	COS	SIN	COS	
0	0.25882	0.96593	0.27564	0.96126	0.29237	0.95630	0.30902	0.95106	0.32557	0.94552	60
1	0.25910	0.96585	0.27592	0.96118	0.29265	0.95622	0.30929	0.95097	0.32584	0.94542	59
2	0.25938	0.96578	0.27620	0.96110	0.29293	0.95613	0.30957	0.95088	0.32612	0.94533	58
3	0.25966	0.96570	0.27648	0.96102	0.29321	0.95605	0.30985	0.95079	0.32639	0.94523	57
4	0.25994	0.96562	0.27676	0.96094	0.29348	0.95596	0.31012	0.95070	0.32667	0.94514	56
5	0.26022	0.96555	0.27704	0.96086	0.29376	0.95588	0.31040	0.95061	0.32694	0.94504	55
6	0.26050	0.96547	0.27731	0.96078	0.29404	0.95579	0.31068	0.95052	0.32722	0.94495	54
7	0.26079	0.96540	0.27759	0.96070	0.29432	0.95571	0.31095	0.95043	0.32749	0.94485	53
8	0.26107	0.96532	0.27787	0.96062	0.29460	0.95562	0.31123	0.95033	0.32777	0.94476	52
9	0.26135	0.96524	0.27815	0.96054	0.29487	0.95554	0.31151	0.95024	0.32804	0.94466	51
10	0.26163	0.96517	0.27843	0.96046	0.29515	0.95545	0.31178	0.95015	0.32832	0.94457	50
11	0.26191	0.96509	0.27871	0.96037	0.29543	0.95536	0.31206	0.95006	0.32859	0.94447	49
12	0.26219	0.96502	0.27899	0.96029	0.29571	0.95528	0.31233	0.94997	0.32887	0.94438	48
13	0.26247	0.96494	0.27927	0.96021	0.29599	0.95519	0.31261	0.94988	0.32914	0.94428	47
14	0.26275	0.96486	0.27955	0.96013	0.29626	0.95511	0.31289	0.94979	0.32942	0.94418	46
15	0.26303	0.96479	0.27983	0.96005	0.29654	0.95502	0.31316	0.94970	0.32969	0.94409	45
16	0.26331	0.96471	0.28011	0.95997	0.29682	0.95493	0.31344	0.94961	0.32997	0.94399	44
17	0.26359	0.96463	0.28039	0.95989	0.29710	0.95485	0.31372	0.94952	0.33024	0.94390	43
18	0.26387	0.96456	0.28067	0.95981	0.29737	0.95476	0.31399	0.94943	0.33051	0.94380	42
19	0.26415	0.96448	0.28095	0.95972	0.29765	0.95467	0.31427	0.94933	0.33079	0.94370	41
20	0.26443	0.96440	0.28123	0.95964	0.29793	0.95459	0.31454	0.94924	0.33106	0.94361	40
21	0.26471	0.96433	0.28150	0.95956	0.29821	0.95450	0.31482	0.94915	0.33134	0.94351	39
22	0.26500	0.96425	0.28178	0.95948	0.29849	0.95441	0.31510	0.94906	0.33161	0.94342	38
23	0.26528	0.96417	0.28206	0.95940	0.29876	0.95433	0.31537	0.94897	0.33189	0.94332	37
24	0.26556	0.96410	0.28234	0.95931	0.29904	0.95424	0.31565	0.94888	0.33216	0.94322	36
25	0.26584	0.96402	0.28262	0.95923	0.29932	0.95415	0.31593	0.94878	0.33244	0.94313	35
26	0.26612	0.96394	0.28290	0.95915	0.29960	0.95407	0.31620	0.94869	0.33271	0.94303	34
27	0.26640	0.96386	0.28318	0.95907	0.29987	0.95398	0.31648	0.94860	0.33298	0.94293	33
28	0.26668	0.96379	0.28346	0.95898	0.30015	0.95389	0.31675	0.94851	0.33326	0.94284	32
29	0.26696	0.96371	0.28374	0.95890	0.30043	0.95380	0.31703	0.94842	0.33353	0.94274	31
30	0.26724	0.96363	0.28402	0.95882	0.30071	0.95372	0.31730	0.94832	0.33381	0.94264	30
31	0.26752	0.96355	0.28429	0.95874	0.30098	0.95363	0.31758	0.94823	0.33408	0.94254	29
32	0.26780	0.96347	0.28457	0.95865	0.30126	0.95354	0.31786	0.94814	0.33436	0.94245	28
33	0.26808	0.96340	0.28485	0.95857	0.30154	0.95345	0.31813	0.94805	0.33463	0.94235	27
34	0.26836	0.96332	0.28513	0.95849	0.30182	0.95337	0.31841	0.94795	0.33490	0.94225	26
35	0.26864	0.96324	0.28541	0.95841	0.30209	0.95328	0.31868	0.94786	0.33518	0.94215	25
36	0.26892	0.96316	0.28569	0.95832	0.30237	0.95319	0.31896	0.94777	0.33545	0.94206	24
37	0.26920	0.96308	0.28597	0.95824	0.30265	0.95310	0.31923	0.94768	0.33573	0.94196	23
38	0.26948	0.96301	0.28625	0.95816	0.30292	0.95301	0.31951	0.94758	0.33600	0.94186	22
39	0.26976	0.96293	0.28652	0.95807	0.30320	0.95293	0.31979	0.94749	0.33627	0.94176	21
40	0.27004	0.96285	0.28680	0.95799	0.30348	0.95284	0.32006	0.94740	0.33655	0.94167	20
41	0.27032	0.96277	0.28708	0.95791	0.30376	0.95275	0.32034	0.94730	0.33682	0.94157	19
42	0.27060	0.96269	0.28736	0.95782	0.30403	0.95266	0.32061	0.94721	0.33710	0.94147	18
43	0.27088	0.96261	0.28764	0.95774	0.30431	0.95257	0.32089	0.94712	0.33737	0.94137	17
44	0.27116	0.96253	0.28792	0.95766	0.30459	0.95248	0.32116	0.94702	0.33764	0.94127	16
45	0.27144	0.96246	0.28820	0.95757	0.30486	0.95240	0.32144	0.94693	0.33792	0.94118	15
46	0.27172	0.96238	0.28847	0.95749	0.30514	0.95231	0.32171	0.94684	0.33819	0.94108	14
47	0.27200	0.96230	0.28875	0.95740	0.30542	0.95222	0.32199	0.94674	0.33846	0.94098	13
48	0.27228	0.96222	0.28903	0.95732	0.30570	0.95213	0.32227	0.94665	0.33874	0.94088	12
49	0.27256	0.96214	0.28931	0.95724	0.30597	0.95204	0.32254	0.94656	0.33901	0.94078	11
50	0.27284	0.96206	0.28959	0.95715	0.30625	0.95195	0.32282	0.94646	0.33929	0.94068	10
51	0.27312	0.96198	0.28987	0.95707	0.30653	0.95186	0.32309	0.94637	0.33956	0.94058	9
52	0.27340	0.96190	0.29015	0.95698	0.30680	0.95177	0.32337	0.94627	0.33983	0.94049	8
53	0.27368	0.96182	0.29042	0.95690	0.30708	0.95168	0.32364	0.94618	0.34011	0.94039	7
54	0.27396	0.96174	0.29070	0.95681	0.30736	0.95159	0.32392	0.94609	0.34038	0.94029	6
55	0.27424	0.96166	0.29098	0.95673	0.30763	0.95150	0.32419	0.94599	0.34065	0.94019	5
56	0.27452	0.96158	0.29126	0.95664	0.30791	0.95142	0.32447	0.94590	0.34093	0.94009	4
57	0.27480	0.96150	0.29154	0.95656	0.30819	0.95133	0.32474	0.94580	0.34120	0.93999	3
58	0.27508	0.96142	0.29182	0.95647	0.30846	0.95124	0.32502	0.94571	0.34147	0.93989	2
59	0.27536	0.96134	0.29209	0.95639	0.30874	0.95115	0.32529	0.94561	0.34175	0.93979	1
60	0.27564	0.96126	0.29237	0.95630	0.30902	0.95106	0.32557	0.94552	0.34202	0.93969	0
	COS	SIN	COS	SIN	COS	SIN	COS	SIN	COS	SIN	MIN
	74°		73°		72°		71°		70°		

Table AII-1.—Natural Sines and Cosines—Continued

MIN	20°		21°		22°		23°		24°		
	SIN	COS	SIN	COS	SIN	COS	SIN	COS	SIN	COS	
0	0.34202	0.93969	0.35837	0.93358	0.37461	0.92718	0.39073	0.92050	0.40674	0.91355	60
1	0.34229	0.93959	0.35864	0.93348	0.37488	0.92707	0.39100	0.92039	0.40700	0.91343	59
2	0.34257	0.93949	0.35891	0.93337	0.37515	0.92697	0.39127	0.92028	0.40727	0.91331	58
3	0.34284	0.93939	0.35918	0.93327	0.37542	0.92686	0.39153	0.92016	0.40753	0.91319	57
4	0.34311	0.93929	0.35945	0.93316	0.37569	0.92675	0.39180	0.92005	0.40780	0.91307	56
5	0.34339	0.93919	0.35973	0.93306	0.37595	0.92664	0.39207	0.91994	0.40806	0.91295	55
6	0.34366	0.93909	0.36000	0.93295	0.37622	0.92653	0.39234	0.91982	0.40833	0.91283	54
7	0.34393	0.93899	0.36027	0.93285	0.37649	0.92642	0.39260	0.91971	0.40860	0.91272	53
8	0.34421	0.93889	0.36054	0.93274	0.37676	0.92631	0.39287	0.91959	0.40886	0.91260	52
9	0.34448	0.93879	0.36081	0.93264	0.37703	0.92620	0.39314	0.91948	0.40913	0.91248	51
10	0.34475	0.93869	0.36108	0.93253	0.37730	0.92609	0.39341	0.91936	0.40939	0.91236	50
11	0.34503	0.93859	0.36135	0.93243	0.37757	0.92598	0.39367	0.91925	0.40966	0.91224	49
12	0.34530	0.93849	0.36162	0.93232	0.37784	0.92587	0.39394	0.91914	0.40992	0.91212	48
13	0.34557	0.93839	0.36190	0.93222	0.37811	0.92576	0.39421	0.91902	0.41019	0.91200	47
14	0.34584	0.93829	0.36217	0.93211	0.37838	0.92565	0.39448	0.91891	0.41045	0.91188	46
15	0.34612	0.93819	0.36244	0.93201	0.37865	0.92554	0.39474	0.91879	0.41072	0.91176	45
16	0.34639	0.93809	0.36271	0.93190	0.37892	0.92543	0.39501	0.91868	0.41098	0.91164	44
17	0.34666	0.93799	0.36298	0.93180	0.37919	0.92532	0.39528	0.91856	0.41125	0.91152	43
18	0.34694	0.93789	0.36325	0.93169	0.37946	0.92521	0.39555	0.91845	0.41151	0.91140	42
19	0.34721	0.93779	0.36352	0.93159	0.37973	0.92510	0.39581	0.91833	0.41178	0.91128	41
20	0.34748	0.93769	0.36379	0.93148	0.37999	0.92499	0.39608	0.91822	0.41204	0.91116	40
21	0.34775	0.93759	0.36406	0.93137	0.38026	0.92488	0.39635	0.91810	0.41231	0.91104	39
22	0.34803	0.93748	0.36434	0.93127	0.38053	0.92477	0.39661	0.91799	0.41257	0.91092	38
23	0.34830	0.93738	0.36461	0.93116	0.38080	0.92466	0.39688	0.91787	0.41284	0.91080	37
24	0.34857	0.93728	0.36488	0.93106	0.38107	0.92455	0.39715	0.91775	0.41310	0.91068	36
25	0.34884	0.93718	0.36515	0.93095	0.38134	0.92444	0.39741	0.91764	0.41337	0.91056	35
26	0.34912	0.93708	0.36542	0.93084	0.38161	0.92432	0.39768	0.91752	0.41363	0.91044	34
27	0.34939	0.93698	0.36569	0.93074	0.38188	0.92421	0.39795	0.91741	0.41390	0.91032	33
28	0.34966	0.93688	0.36596	0.93063	0.38215	0.92410	0.39822	0.91729	0.41416	0.91020	32
29	0.34993	0.93677	0.36623	0.93052	0.38241	0.92399	0.39848	0.91718	0.41443	0.91008	31
30	0.35021	0.93667	0.36650	0.93042	0.38268	0.92388	0.39875	0.91706	0.41469	0.90996	30
31	0.35048	0.93657	0.36677	0.93031	0.38295	0.92377	0.39902	0.91694	0.41496	0.90984	29
32	0.35075	0.93647	0.36704	0.93020	0.38322	0.92366	0.39928	0.91683	0.41522	0.90972	28
33	0.35102	0.93637	0.36731	0.93010	0.38349	0.92355	0.39955	0.91671	0.41549	0.90960	27
34	0.35130	0.93626	0.36758	0.92999	0.38376	0.92343	0.39982	0.91660	0.41575	0.90948	26
35	0.35157	0.93616	0.36785	0.92988	0.38403	0.92332	0.40008	0.91648	0.41602	0.90936	25
36	0.35184	0.93606	0.36812	0.92978	0.38430	0.92321	0.40035	0.91636	0.41628	0.90924	24
37	0.35211	0.93596	0.36839	0.92967	0.38456	0.92310	0.40062	0.91625	0.41655	0.90911	23
38	0.35239	0.93585	0.36867	0.92956	0.38483	0.92299	0.40088	0.91613	0.41681	0.90899	22
39	0.35266	0.93575	0.36894	0.92945	0.38510	0.92287	0.40115	0.91601	0.41707	0.90887	21
40	0.35293	0.93565	0.36921	0.92935	0.38537	0.92276	0.40141	0.91590	0.41734	0.90875	20
41	0.35320	0.93555	0.36948	0.92924	0.38564	0.92265	0.40168	0.91578	0.41760	0.90863	19
42	0.35347	0.93544	0.36975	0.92913	0.38591	0.92254	0.40195	0.91566	0.41787	0.90851	18
43	0.35375	0.93534	0.37002	0.92902	0.38617	0.92243	0.40221	0.91555	0.41813	0.90839	17
44	0.35402	0.93524	0.37029	0.92892	0.38644	0.92231	0.40248	0.91543	0.41840	0.90826	16
45	0.35429	0.93514	0.37056	0.92881	0.38671	0.92220	0.40275	0.91531	0.41866	0.90814	15
46	0.35456	0.93503	0.37083	0.92870	0.38698	0.92209	0.40301	0.91519	0.41892	0.90802	14
47	0.35484	0.93493	0.37110	0.92859	0.38725	0.92198	0.40328	0.91508	0.41919	0.90790	13
48	0.35511	0.93483	0.37137	0.92849	0.38752	0.92186	0.40355	0.91496	0.41945	0.90778	12
49	0.35538	0.93472	0.37164	0.92838	0.38778	0.92175	0.40381	0.91484	0.41972	0.90766	11
50	0.35565	0.93462	0.37191	0.92827	0.38805	0.92164	0.40408	0.91472	0.41998	0.90753	10
51	0.35592	0.93452	0.37218	0.92816	0.38832	0.92152	0.40434	0.91461	0.42024	0.90741	9
52	0.35619	0.93441	0.37245	0.92805	0.38859	0.92141	0.40461	0.91449	0.42051	0.90729	8
53	0.35647	0.93431	0.37272	0.92794	0.38886	0.92130	0.40488	0.91437	0.42077	0.90717	7
54	0.35674	0.93420	0.37299	0.92784	0.38912	0.92119	0.40514	0.91425	0.42104	0.90704	6
55	0.35701	0.93410	0.37326	0.92773	0.38939	0.92107	0.40541	0.91414	0.42130	0.90692	5
56	0.35728	0.93400	0.37353	0.92762	0.38966	0.92096	0.40567	0.91402	0.42156	0.90680	4
57	0.35755	0.93389	0.37380	0.92751	0.38993	0.92085	0.40594	0.91390	0.42183	0.90668	3
58	0.35782	0.93379	0.37407	0.92740	0.39020	0.92073	0.40621	0.91378	0.42209	0.90655	2
59	0.35810	0.93368	0.37434	0.92729	0.39046	0.92062	0.40647	0.91366	0.42235	0.90643	1
60	0.35837	0.93358	0.37461	0.92718	0.39073	0.92050	0.40674	0.91355	0.42262	0.90631	0
	COS	SIN	COS	SIN	COS	SIN	COS	SIN	COS	SIN	MIN
	69°		68°		67°		66°		65°		

Table AII-1.—Natural Sines and Cosines—Continued

M I N	25° SIN	25° COS	26° SIN	26° COS	27° SIN	27° COS	28° SIN	28° COS	29° SIN	29° COS	
0	0.42262	0.90631	0.43837	0.89879	0.45399	0.89101	0.46947	0.88295	0.48481	0.87462	60
1	0.42288	0.90618	0.43863	0.89867	0.45425	0.89087	0.46973	0.88281	0.48506	0.87448	59
2	0.42315	0.90606	0.43889	0.89854	0.45451	0.89074	0.46999	0.88267	0.48532	0.87434	58
3	0.42341	0.90594	0.43916	0.89841	0.45477	0.89061	0.47024	0.88254	0.48557	0.87420	57
4	0.42367	0.90582	0.43942	0.89828	0.45503	0.89048	0.47050	0.88240	0.48583	0.87406	56
5	0.42394	0.90569	0.43968	0.89816	0.45529	0.89035	0.47076	0.88226	0.48608	0.87391	55
6	0.42420	0.90557	0.43994	0.89803	0.45554	0.89021	0.47101	0.88213	0.48634	0.87377	54
7	0.42446	0.90545	0.44020	0.89790	0.45580	0.89008	0.47127	0.88199	0.48659	0.87363	53
8	0.42473	0.90532	0.44046	0.89777	0.45606	0.88995	0.47153	0.88185	0.48684	0.87349	52
9	0.42499	0.90520	0.44072	0.89764	0.45632	0.88981	0.47178	0.88172	0.48710	0.87335	51
10	0.42525	0.90507	0.44098	0.89752	0.45658	0.88968	0.47204	0.88158	0.48735	0.87321	50
11	0.42552	0.90495	0.44124	0.89739	0.45684	0.88955	0.47229	0.88144	0.48761	0.87306	49
12	0.42578	0.90483	0.44151	0.89726	0.45710	0.88942	0.47255	0.88130	0.48786	0.87292	48
13	0.42604	0.90470	0.44177	0.89713	0.45736	0.88928	0.47281	0.88117	0.48811	0.87278	47
14	0.42631	0.90458	0.44203	0.89700	0.45762	0.88915	0.47306	0.88103	0.48837	0.87264	46
15	0.42657	0.90446	0.44229	0.89687	0.45787	0.88902	0.47332	0.88089	0.48862	0.87250	45
16	0.42683	0.90433	0.44255	0.89674	0.45813	0.88888	0.47358	0.88075	0.48888	0.87235	44
17	0.42709	0.90421	0.44281	0.89662	0.45839	0.88875	0.47383	0.88062	0.48913	0.87221	43
18	0.42736	0.90408	0.44307	0.89649	0.45865	0.88862	0.47409	0.88048	0.48938	0.87207	42
19	0.42762	0.90396	0.44333	0.89636	0.45891	0.88848	0.47434	0.88034	0.48964	0.87193	41
20	0.42788	0.90383	0.44359	0.89623	0.45917	0.88835	0.47460	0.88020	0.48989	0.87178	40
21	0.42815	0.90371	0.44385	0.89610	0.45942	0.88822	0.47486	0.88006	0.49014	0.87164	39
22	0.42841	0.90358	0.44411	0.89597	0.45968	0.88808	0.47511	0.87993	0.49040	0.87150	38
23	0.42867	0.90346	0.44437	0.89584	0.45994	0.88795	0.47537	0.87979	0.49065	0.87136	37
24	0.42894	0.90334	0.44464	0.89571	0.46020	0.88782	0.47562	0.87965	0.49090	0.87121	36
25	0.42920	0.90321	0.44490	0.89558	0.46046	0.88768	0.47588	0.87951	0.49116	0.87107	35
26	0.42946	0.90309	0.44516	0.89545	0.46072	0.88755	0.47614	0.87937	0.49141	0.87093	34
27	0.42972	0.90296	0.44542	0.89532	0.46097	0.88741	0.47639	0.87923	0.49166	0.87079	33
28	0.42999	0.90284	0.44568	0.89519	0.46123	0.88728	0.47665	0.87909	0.49192	0.87064	32
29	0.43025	0.90271	0.44594	0.89506	0.46149	0.88715	0.47690	0.87896	0.49217	0.87050	31
30	0.43051	0.90259	0.44620	0.89493	0.46175	0.88701	0.47716	0.87882	0.49242	0.87036	30
31	0.43077	0.90246	0.44646	0.89480	0.46201	0.88688	0.47741	0.87868	0.49268	0.87021	29
32	0.43104	0.90233	0.44672	0.89467	0.46226	0.88674	0.47767	0.87854	0.49293	0.87007	28
33	0.43130	0.90221	0.44698	0.89454	0.46252	0.88661	0.47793	0.87840	0.49318	0.86993	27
34	0.43156	0.90208	0.44724	0.89441	0.46278	0.88647	0.47818	0.87826	0.49344	0.86978	26
35	0.43182	0.90196	0.44750	0.89428	0.46304	0.88634	0.47844	0.87812	0.49369	0.86964	25
36	0.43209	0.90183	0.44776	0.89415	0.46330	0.88620	0.47869	0.87798	0.49394	0.86949	24
37	0.43235	0.90171	0.44802	0.89402	0.46355	0.88607	0.47895	0.87784	0.49419	0.86935	23
38	0.43261	0.90158	0.44828	0.89389	0.46381	0.88593	0.47920	0.87770	0.49445	0.86921	22
39	0.43287	0.90146	0.44854	0.89376	0.46407	0.88580	0.47946	0.87756	0.49470	0.86906	21
40	0.43313	0.90133	0.44880	0.89363	0.46433	0.88566	0.47971	0.87743	0.49495	0.86892	20
41	0.43340	0.90120	0.44906	0.89350	0.46458	0.88553	0.47997	0.87729	0.49521	0.86878	19
42	0.43366	0.90108	0.44932	0.89337	0.46484	0.88539	0.48022	0.87715	0.49546	0.86863	18
43	0.43392	0.90095	0.44958	0.89324	0.46510	0.88526	0.48048	0.87701	0.49571	0.86849	17
44	0.43418	0.90082	0.44984	0.89311	0.46536	0.88512	0.48073	0.87687	0.49596	0.86834	16
45	0.43445	0.90070	0.45010	0.89298	0.46561	0.88499	0.48099	0.87673	0.49622	0.86820	15
46	0.43471	0.90057	0.45036	0.89285	0.46587	0.88485	0.48124	0.87659	0.49647	0.86805	14
47	0.43497	0.90045	0.45062	0.89272	0.46613	0.88472	0.48150	0.87645	0.49672	0.86791	13
48	0.43523	0.90032	0.45088	0.89259	0.46639	0.88458	0.48175	0.87631	0.49697	0.86777	12
49	0.43549	0.90019	0.45114	0.89245	0.46664	0.88445	0.48201	0.87617	0.49723	0.86762	11
50	0.43575	0.90007	0.45140	0.89232	0.46690	0.88431	0.48226	0.87603	0.49748	0.86748	10
51	0.43602	0.89994	0.45166	0.89219	0.46716	0.88417	0.48252	0.87589	0.49773	0.86733	9
52	0.43628	0.89981	0.45192	0.89206	0.46742	0.88404	0.48277	0.87575	0.49798	0.86719	8
53	0.43654	0.89968	0.45218	0.89193	0.46767	0.88390	0.48303	0.87561	0.49824	0.86704	7
54	0.43680	0.89956	0.45243	0.89180	0.46793	0.88377	0.48328	0.87546	0.49849	0.86690	6
55	0.43706	0.89943	0.45269	0.89167	0.46819	0.88363	0.48354	0.87532	0.49874	0.86675	5
56	0.43733	0.89930	0.45295	0.89153	0.46844	0.88349	0.48379	0.87518	0.49899	0.86661	4
57	0.43759	0.89918	0.45321	0.89140	0.46870	0.88336	0.48405	0.87504	0.49924	0.86646	3
58	0.43785	0.89905	0.45347	0.89127	0.46896	0.88322	0.48430	0.87490	0.49950	0.86632	2
59	0.43811	0.89892	0.45373	0.89114	0.46921	0.88308	0.48456	0.87476	0.49975	0.86617	1
60	0.43837	0.89879	0.45399	0.89101	0.46947	0.88295	0.48481	0.87462	0.50000	0.86603	0
M I N	COS	SIN	COS	SIN	COS	SIN	COS	SIN	COS	SIN	M I N
	64°		63°		62°		61°		60°		

Table AII-1.—Natural Sines and Cosines—Continued

MIN	30° SIN	30° COS	31° SIN	31° COS	32° SIN	32° COS	33° SIN	33° COS	34° SIN	34° COS	MIN
0	0.50000	0.86603	0.51504	0.85717	0.52992	0.84805	0.54464	0.83867	0.55919	0.82904	60
1	0.50025	0.86588	0.51529	0.85702	0.53017	0.84789	0.54488	0.83851	0.55943	0.82887	59
2	0.50050	0.86573	0.51554	0.85687	0.53041	0.84774	0.54513	0.83835	0.55968	0.82871	58
3	0.50076	0.86559	0.51579	0.85672	0.53066	0.84759	0.54537	0.83819	0.55992	0.82855	57
4	0.50101	0.86544	0.51604	0.85657	0.53091	0.84743	0.54561	0.83804	0.56016	0.82839	56
5	0.50126	0.86530	0.51628	0.85642	0.53115	0.84728	0.54586	0.83788	0.56040	0.82822	55
6	0.50151	0.86515	0.51653	0.85627	0.53140	0.84712	0.54610	0.83772	0.56064	0.82806	54
7	0.50176	0.86501	0.51678	0.85612	0.53164	0.84697	0.54635	0.83756	0.56088	0.82790	53
8	0.50201	0.86486	0.51703	0.85597	0.53189	0.84681	0.54659	0.83740	0.56112	0.82773	52
9	0.50227	0.86471	0.51728	0.85582	0.53214	0.84666	0.54683	0.83724	0.56136	0.82757	51
10	0.50252	0.86457	0.51753	0.85567	0.53238	0.84650	0.54708	0.83708	0.56160	0.82741	50
11	0.50277	0.86442	0.51778	0.85551	0.53263	0.84635	0.54732	0.83692	0.56184	0.82724	49
12	0.50302	0.86427	0.51803	0.85536	0.53288	0.84619	0.54756	0.83676	0.56208	0.82708	48
13	0.50327	0.86413	0.51828	0.85521	0.53312	0.84604	0.54781	0.83660	0.56232	0.82692	47
14	0.50352	0.86398	0.51852	0.85506	0.53337	0.84588	0.54805	0.83645	0.56256	0.82675	46
15	0.50377	0.86384	0.51877	0.85491	0.53361	0.84573	0.54829	0.83629	0.56280	0.82659	45
16	0.50403	0.86369	0.51902	0.85476	0.53386	0.84557	0.54854	0.83613	0.56305	0.82643	44
17	0.50428	0.86354	0.51927	0.85461	0.53411	0.84542	0.54878	0.83597	0.56329	0.82626	43
18	0.50453	0.86340	0.51952	0.85446	0.53435	0.84526	0.54902	0.83581	0.56353	0.82610	42
19	0.50478	0.86325	0.51977	0.85431	0.53460	0.84511	0.54927	0.83565	0.56377	0.82593	41
20	0.50503	0.86310	0.52002	0.85416	0.53484	0.84495	0.54951	0.83549	0.56401	0.82577	40
21	0.50528	0.86295	0.52026	0.85401	0.53509	0.84480	0.54975	0.83533	0.56425	0.82561	39
22	0.50553	0.86281	0.52051	0.85385	0.53534	0.84464	0.54999	0.83517	0.56449	0.82544	38
23	0.50578	0.86266	0.52076	0.85370	0.53558	0.84448	0.55024	0.83501	0.56473	0.82528	37
24	0.50603	0.86251	0.52101	0.85355	0.53583	0.84433	0.55048	0.83485	0.56497	0.82511	36
25	0.50628	0.86237	0.52126	0.85340	0.53607	0.84417	0.55072	0.83469	0.56521	0.82495	35
26	0.50654	0.86222	0.52151	0.85325	0.53632	0.84402	0.55097	0.83453	0.56545	0.82478	34
27	0.50679	0.86207	0.52175	0.85310	0.53656	0.84386	0.55121	0.83437	0.56569	0.82462	33
28	0.50704	0.86192	0.52200	0.85294	0.53681	0.84370	0.55145	0.83421	0.56593	0.82446	32
29	0.50729	0.86178	0.52225	0.85279	0.53705	0.84355	0.55169	0.83405	0.56617	0.82429	31
30	0.50754	0.86163	0.52250	0.85264	0.53730	0.84339	0.55194	0.83389	0.56641	0.82413	30
31	0.50779	0.86148	0.52275	0.85249	0.53754	0.84324	0.55218	0.83373	0.56665	0.82396	29
32	0.50804	0.86133	0.52299	0.85234	0.53779	0.84308	0.55242	0.83356	0.56689	0.82380	28
33	0.50829	0.86119	0.52324	0.85218	0.53804	0.84292	0.55266	0.83340	0.56713	0.82363	27
34	0.50854	0.86104	0.52349	0.85203	0.53828	0.84277	0.55291	0.83324	0.56736	0.82347	26
35	0.50879	0.86089	0.52374	0.85188	0.53853	0.84261	0.55315	0.83308	0.56760	0.82330	25
36	0.50904	0.86074	0.52399	0.85173	0.53877	0.84245	0.55339	0.83292	0.56784	0.82314	24
37	0.50929	0.86059	0.52423	0.85157	0.53902	0.84230	0.55363	0.83276	0.56808	0.82297	23
38	0.50954	0.86045	0.52448	0.85142	0.53926	0.84214	0.55388	0.83260	0.56832	0.82281	22
39	0.50979	0.86030	0.52473	0.85127	0.53951	0.84198	0.55412	0.83244	0.56856	0.82264	21
40	0.51004	0.86015	0.52498	0.85112	0.53975	0.84182	0.55436	0.83228	0.56880	0.82248	20
41	0.51029	0.86000	0.52522	0.85096	0.54000	0.84167	0.55460	0.83212	0.56904	0.82231	19
42	0.51054	0.85985	0.52547	0.85081	0.54024	0.84151	0.55484	0.83195	0.56928	0.82214	18
43	0.51079	0.85970	0.52572	0.85066	0.54049	0.84135	0.55509	0.83179	0.56952	0.82198	17
44	0.51104	0.85956	0.52597	0.85051	0.54073	0.84120	0.55533	0.83163	0.56976	0.82181	16
45	0.51129	0.85941	0.52621	0.85035	0.54097	0.84104	0.55557	0.83147	0.57000	0.82165	15
46	0.51154	0.85926	0.52646	0.85020	0.54122	0.84088	0.55581	0.83131	0.57024	0.82148	14
47	0.51179	0.85911	0.52671	0.85005	0.54146	0.84072	0.55605	0.83115	0.57047	0.82132	13
48	0.51204	0.85896	0.52696	0.84989	0.54171	0.84057	0.55630	0.83098	0.57071	0.82115	12
49	0.51229	0.85881	0.52720	0.84974	0.54195	0.84041	0.55654	0.83082	0.57095	0.82098	11
50	0.51254	0.85866	0.52745	0.84959	0.54220	0.84025	0.55678	0.83066	0.57119	0.82082	10
51	0.51279	0.85851	0.52770	0.84943	0.54244	0.84009	0.55702	0.83050	0.57143	0.82065	9
52	0.51304	0.85836	0.52794	0.84928	0.54269	0.83994	0.55726	0.83034	0.57167	0.82048	8
53	0.51329	0.85821	0.52819	0.84913	0.54293	0.83978	0.55750	0.83017	0.57191	0.82032	7
54	0.51354	0.85806	0.52844	0.84897	0.54317	0.83962	0.55775	0.83001	0.57215	0.82015	6
55	0.51379	0.85792	0.52869	0.84882	0.54342	0.83946	0.55799	0.82985	0.57238	0.81999	5
56	0.51404	0.85777	0.52893	0.84866	0.54366	0.83930	0.55823	0.82969	0.57262	0.81982	4
57	0.51429	0.85762	0.52918	0.84851	0.54391	0.83915	0.55847	0.82953	0.57286	0.81965	3
58	0.51454	0.85747	0.52943	0.84836	0.54415	0.83899	0.55871	0.82936	0.57310	0.81949	2
59	0.51479	0.85732	0.52967	0.84820	0.54440	0.83883	0.55895	0.82920	0.57334	0.81932	1
60	0.51504	0.85717	0.52992	0.84805	0.54464	0.83867	0.55919	0.82904	0.57358	0.81915	0
	COS	SIN	COS	SIN	COS	SIN	COS	SIN	COS	SIN	MIN
	59°		58°		57°		56°		55°		

Table AII-1.—Natural Sines and Cosines—Continued

MIN	35°		36°		37°		38°		39°		
	SIN	COS	SIN	COS	SIN	COS	SIN	COS	SIN	COS	
0	0.57358	0.81915	0.58779	0.80902	0.60182	0.79864	0.61566	0.78801	0.62932	0.77715	60
1	0.57381	0.81899	0.58802	0.80885	0.60205	0.79846	0.61589	0.78783	0.62955	0.77696	59
2	0.57405	0.81882	0.58826	0.80867	0.60228	0.79829	0.61612	0.78765	0.62977	0.77678	58
3	0.57429	0.81865	0.58849	0.80850	0.60251	0.79811	0.61635	0.78747	0.63000	0.77660	57
4	0.57453	0.81848	0.58873	0.80833	0.60274	0.79793	0.61658	0.78729	0.63022	0.77641	56
5	0.57477	0.81832	0.58896	0.80816	0.60298	0.79776	0.61681	0.78711	0.63045	0.77623	55
6	0.57501	0.81815	0.58920	0.80799	0.60321	0.79758	0.61704	0.78694	0.63068	0.77605	54
7	0.57524	0.81798	0.58943	0.80782	0.60344	0.79741	0.61726	0.78676	0.63090	0.77586	53
8	0.57548	0.81782	0.58967	0.80765	0.60367	0.79723	0.61749	0.78658	0.63113	0.77568	52
9	0.57572	0.81765	0.58990	0.80748	0.60390	0.79706	0.61772	0.78640	0.63135	0.77550	51
10	0.57596	0.81748	0.59014	0.80730	0.60414	0.79688	0.61795	0.78622	0.63158	0.77531	50
11	0.57619	0.81731	0.59037	0.80713	0.60437	0.79671	0.61818	0.78604	0.63180	0.77513	49
12	0.57643	0.81714	0.59061	0.80696	0.60460	0.79653	0.61841	0.78586	0.63203	0.77494	48
13	0.57667	0.81698	0.59084	0.80679	0.60483	0.79635	0.61864	0.78568	0.63225	0.77476	47
14	0.57691	0.81681	0.59108	0.80662	0.60506	0.79618	0.61887	0.78550	0.63248	0.77458	46
15	0.57715	0.81664	0.59131	0.80644	0.60529	0.79600	0.61909	0.78532	0.63271	0.77439	45
16	0.57738	0.81647	0.59154	0.80627	0.60553	0.79583	0.61932	0.78514	0.63293	0.77421	44
17	0.57762	0.81631	0.59178	0.80610	0.60576	0.79565	0.61955	0.78496	0.63316	0.77402	43
18	0.57786	0.81614	0.59201	0.80593	0.60599	0.79547	0.61978	0.78478	0.63338	0.77384	42
19	0.57810	0.81597	0.59225	0.80576	0.60622	0.79530	0.62001	0.78460	0.63361	0.77366	41
20	0.57833	0.81580	0.59248	0.80558	0.60645	0.79512	0.62024	0.78442	0.63383	0.77347	40
21	0.57857	0.81563	0.59272	0.80541	0.60668	0.79494	0.62046	0.78424	0.63406	0.77329	39
22	0.57881	0.81546	0.59295	0.80524	0.60691	0.79477	0.62069	0.78405	0.63428	0.77310	38
23	0.57904	0.81530	0.59318	0.80507	0.60714	0.79459	0.62092	0.78387	0.63451	0.77292	37
24	0.57928	0.81513	0.59342	0.80489	0.60738	0.79441	0.62115	0.78369	0.63473	0.77273	36
25	0.57952	0.81496	0.59365	0.80472	0.60761	0.79424	0.62138	0.78351	0.63496	0.77255	35
26	0.57976	0.81479	0.59389	0.80455	0.60784	0.79406	0.62160	0.78333	0.63518	0.77236	34
27	0.57999	0.81462	0.59412	0.80438	0.60807	0.79388	0.62183	0.78315	0.63540	0.77218	33
28	0.58023	0.81445	0.59436	0.80420	0.60830	0.79371	0.62206	0.78297	0.63563	0.77199	32
29	0.58047	0.81428	0.59459	0.80403	0.60853	0.79353	0.62229	0.78279	0.63585	0.77181	31
30	0.58070	0.81412	0.59482	0.80386	0.60876	0.79335	0.62251	0.78261	0.63608	0.77162	30
31	0.58094	0.81395	0.59506	0.80368	0.60899	0.79318	0.62274	0.78243	0.63630	0.77144	29
32	0.58118	0.81378	0.59529	0.80351	0.60922	0.79300	0.62297	0.78225	0.63653	0.77125	28
33	0.58141	0.81361	0.59552	0.80334	0.60945	0.79282	0.62320	0.78206	0.63675	0.77107	27
34	0.58165	0.81344	0.59576	0.80316	0.60968	0.79264	0.62342	0.78188	0.63698	0.77088	26
35	0.58189	0.81327	0.59599	0.80299	0.60991	0.79247	0.62365	0.78170	0.63720	0.77070	25
36	0.58212	0.81310	0.59622	0.80282	0.61015	0.79229	0.62388	0.78152	0.63742	0.77051	24
37	0.58236	0.81293	0.59646	0.80264	0.61038	0.79211	0.62411	0.78134	0.63765	0.77033	23
38	0.58260	0.81276	0.59669	0.80247	0.61061	0.79193	0.62433	0.78116	0.63787	0.77014	22
39	0.58283	0.81259	0.59693	0.80230	0.61084	0.79176	0.62456	0.78098	0.63810	0.76996	21
40	0.58307	0.81242	0.59716	0.80212	0.61107	0.79158	0.62479	0.78079	0.63832	0.76977	20
41	0.58330	0.81225	0.59739	0.80195	0.61130	0.79140	0.62502	0.78061	0.63854	0.76959	19
42	0.58354	0.81208	0.59763	0.80178	0.61153	0.79122	0.62524	0.78043	0.63877	0.76940	18
43	0.58378	0.81191	0.59786	0.80160	0.61176	0.79105	0.62547	0.78025	0.63899	0.76921	17
44	0.58401	0.81174	0.59809	0.80143	0.61199	0.79087	0.62570	0.78007	0.63922	0.76903	16
45	0.58425	0.81157	0.59832	0.80125	0.61222	0.79069	0.62592	0.77988	0.63944	0.76884	15
46	0.58449	0.81140	0.59856	0.80108	0.61245	0.79051	0.62615	0.77970	0.63966	0.76866	14
47	0.58472	0.81123	0.59879	0.80091	0.61268	0.79033	0.62638	0.77952	0.63989	0.76847	13
48	0.58496	0.81106	0.59902	0.80073	0.61291	0.79016	0.62660	0.77934	0.64011	0.76828	12
49	0.58519	0.81089	0.59926	0.80056	0.61314	0.78998	0.62683	0.77916	0.64033	0.76810	11
50	0.58543	0.81072	0.59949	0.80038	0.61337	0.78980	0.62706	0.77897	0.64056	0.76791	10
51	0.58567	0.81055	0.59972	0.80021	0.61360	0.78962	0.62728	0.77879	0.64078	0.76772	9
52	0.58590	0.81038	0.59995	0.80003	0.61383	0.78944	0.62751	0.77861	0.64100	0.76754	8
53	0.58614	0.81021	0.60019	0.79986	0.61406	0.78926	0.62774	0.77843	0.64123	0.76735	7
54	0.58637	0.81004	0.60042	0.79968	0.61429	0.78908	0.62796	0.77824	0.64145	0.76717	6
55	0.58661	0.80987	0.60065	0.79951	0.61451	0.78891	0.62819	0.77806	0.64167	0.76698	5
56	0.58684	0.80970	0.60089	0.79934	0.61474	0.78873	0.62842	0.77788	0.64190	0.76679	4
57	0.58708	0.80953	0.60112	0.79916	0.61497	0.78855	0.62864	0.77769	0.64212	0.76661	3
58	0.58731	0.80936	0.60135	0.79899	0.61520	0.78837	0.62887	0.77751	0.64234	0.76642	2
59	0.58755	0.80919	0.60158	0.79881	0.61543	0.78819	0.62909	0.77733	0.64256	0.76623	1
60	0.58779	0.80902	0.60182	0.79864	0.61566	0.78801	0.62932	0.77715	0.64279	0.76604	0
	COS	SIN	COS	SIN	COS	SIN	COS	SIN	COS	SIN	MIN
	54°		53°		52°		51°		50°		

MIN	40° SIN	40° COS	41° SIN	41° COS	42° SIN	42° COS	43° SIN	43° COS	44° SIN	44° COS	
0	0.64279	0.76604	0.65606	0.75471	0.66913	0.74314	0.68200	0.73135	0.69466	0.71934	60
1	0.64301	0.76586	0.65628	0.75452	0.66935	0.74295	0.68221	0.73116	0.69487	0.71914	59
2	0.64323	0.76567	0.65650	0.75433	0.66956	0.74276	0.68242	0.73096	0.69508	0.71894	58
3	0.64346	0.76548	0.65672	0.75414	0.66978	0.74256	0.68264	0.73076	0.69529	0.71873	57
4	0.64368	0.76530	0.65694	0.75395	0.66999	0.74237	0.68285	0.73056	0.69549	0.71853	56
5	0.64390	0.76511	0.65716	0.75375	0.67021	0.74217	0.68306	0.73036	0.69570	0.71833	55
6	0.64412	0.76492	0.65738	0.75356	0.67043	0.74198	0.68327	0.73016	0.69591	0.71813	54
7	0.64435	0.76473	0.65759	0.75337	0.67064	0.74178	0.68349	0.72996	0.69612	0.71792	53
8	0.64457	0.76455	0.65781	0.75318	0.67086	0.74159	0.68370	0.72976	0.69633	0.71772	52
9	0.64479	0.76436	0.65803	0.75299	0.67107	0.74139	0.68391	0.72957	0.69654	0.71752	51
10	0.64501	0.76417	0.65825	0.75280	0.67129	0.74120	0.68412	0.72937	0.69675	0.71732	50
11	0.64524	0.76398	0.65847	0.75261	0.67151	0.74100	0.68434	0.72917	0.69696	0.71711	49
12	0.64546	0.76380	0.65869	0.75241	0.67172	0.74080	0.68455	0.72897	0.69717	0.71691	48
13	0.64568	0.76361	0.65891	0.75222	0.67194	0.74061	0.68476	0.72877	0.69737	0.71671	47
14	0.64590	0.76342	0.65913	0.75203	0.67215	0.74041	0.68497	0.72857	0.69758	0.71650	46
15	0.64612	0.76323	0.65935	0.75184	0.67237	0.74022	0.68518	0.72837	0.69779	0.71630	45
16	0.64635	0.76304	0.65956	0.75165	0.67258	0.74002	0.68539	0.72817	0.69800	0.71610	44
17	0.64657	0.76286	0.65978	0.75146	0.67280	0.73983	0.68561	0.72797	0.69821	0.71590	43
18	0.64679	0.76267	0.66000	0.75126	0.67301	0.73963	0.68582	0.72777	0.69842	0.71569	42
19	0.64701	0.76248	0.66022	0.75107	0.67323	0.73944	0.68603	0.72757	0.69862	0.71549	41
20	0.64723	0.76229	0.66044	0.75088	0.67344	0.73924	0.68624	0.72737	0.69883	0.71529	40
21	0.64746	0.76210	0.66066	0.75069	0.67366	0.73904	0.68645	0.72717	0.69904	0.71508	39
22	0.64768	0.76192	0.66088	0.75050	0.67387	0.73885	0.68666	0.72697	0.69925	0.71488	38
23	0.64790	0.76173	0.66109	0.75030	0.67409	0.73865	0.68688	0.72677	0.69946	0.71468	37
24	0.64812	0.76154	0.66131	0.75011	0.67430	0.73846	0.68709	0.72657	0.69966	0.71447	36
25	0.64834	0.76135	0.66153	0.74992	0.67452	0.73826	0.68730	0.72637	0.69987	0.71427	35
26	0.64856	0.76116	0.66175	0.74973	0.67473	0.73806	0.68751	0.72617	0.70008	0.71407	34
27	0.64878	0.76097	0.66197	0.74953	0.67495	0.73787	0.68772	0.72597	0.70029	0.71386	33
28	0.64901	0.76078	0.66218	0.74934	0.67516	0.73767	0.68793	0.72577	0.70049	0.71366	32
29	0.64923	0.76059	0.66240	0.74915	0.67538	0.73747	0.68814	0.72557	0.70070	0.71345	31
30	0.64945	0.76041	0.66262	0.74896	0.67559	0.73728	0.68835	0.72537	0.70091	0.71325	30
31	0.64967	0.76022	0.66284	0.74876	0.67580	0.73708	0.68857	0.72517	0.70112	0.71305	29
32	0.64989	0.76003	0.66306	0.74857	0.67602	0.73688	0.68878	0.72497	0.70132	0.71284	28
33	0.65011	0.75984	0.66327	0.74838	0.67623	0.73669	0.68899	0.72477	0.70153	0.71264	27
34	0.65033	0.75965	0.66349	0.74818	0.67645	0.73649	0.68920	0.72457	0.70174	0.71243	26
35	0.65055	0.75946	0.66371	0.74799	0.67666	0.73629	0.68941	0.72437	0.70195	0.71223	25
36	0.65077	0.75927	0.66393	0.74780	0.67688	0.73610	0.68962	0.72417	0.70215	0.71203	24
37	0.65100	0.75908	0.66414	0.74760	0.67709	0.73590	0.68983	0.72397	0.70236	0.71182	23
38	0.65122	0.75889	0.66436	0.74741	0.67730	0.73570	0.69004	0.72377	0.70257	0.71162	22
39	0.65144	0.75870	0.66458	0.74722	0.67752	0.73551	0.69025	0.72357	0.70277	0.71141	21
40	0.65166	0.75851	0.66480	0.74703	0.67773	0.73531	0.69046	0.72337	0.70298	0.71121	20
41	0.65188	0.75832	0.66501	0.74683	0.67795	0.73511	0.69067	0.72317	0.70319	0.71100	19
42	0.65210	0.75813	0.66523	0.74664	0.67816	0.73491	0.69088	0.72297	0.70339	0.71080	18
43	0.65232	0.75794	0.66545	0.74644	0.67837	0.73472	0.69109	0.72277	0.70360	0.71059	17
44	0.65254	0.75775	0.66566	0.74625	0.67859	0.73452	0.69130	0.72257	0.70381	0.71039	16
45	0.65276	0.75756	0.66588	0.74606	0.67880	0.73432	0.69151	0.72236	0.70401	0.71019	15
46	0.65298	0.75738	0.66610	0.74586	0.67901	0.73413	0.69172	0.72216	0.70422	0.70998	14
47	0.65320	0.75719	0.66632	0.74567	0.67923	0.73393	0.69193	0.72196	0.70443	0.70978	13
48	0.65342	0.75700	0.66653	0.74548	0.67944	0.73373	0.69214	0.72176	0.70463	0.70957	12
49	0.65364	0.75680	0.66675	0.74528	0.67965	0.73353	0.69235	0.72156	0.70484	0.70937	11
50	0.65386	0.75661	0.66697	0.74509	0.67987	0.73333	0.69256	0.72136	0.70505	0.70916	10
51	0.65408	0.75642	0.66718	0.74489	0.68008	0.73314	0.69277	0.72116	0.70525	0.70896	9
52	0.65430	0.75623	0.66740	0.74470	0.68029	0.73294	0.69298	0.72095	0.70546	0.70875	8
53	0.65452	0.75604	0.66762	0.74451	0.68051	0.73274	0.69319	0.72075	0.70567	0.70855	7
54	0.65474	0.75585	0.66783	0.74431	0.68072	0.73254	0.69340	0.72055	0.70587	0.70834	6
55	0.65496	0.75566	0.66805	0.74412	0.68093	0.73234	0.69361	0.72035	0.70608	0.70813	5
56	0.65518	0.75547	0.66827	0.74392	0.68115	0.73215	0.69382	0.72015	0.70628	0.70793	4
57	0.65540	0.75528	0.66848	0.74373	0.68136	0.73195	0.69403	0.71995	0.70649	0.70772	3
58	0.65562	0.75509	0.66870	0.74353	0.68157	0.73175	0.69424	0.71974	0.70670	0.70752	2
59	0.65584	0.75490	0.66891	0.74334	0.68179	0.73155	0.69445	0.71954	0.70690	0.70731	1
60	0.65606	0.75471	0.66913	0.74314	0.68200	0.73135	0.69466	0.71934	0.70711	0.70711	0
MIN	COS	SIN	COS	SIN	COS	SIN	COS	SIN	COS	SIN	MIN
	49°		48°		47°		46°		45°		

Table AII-2.—Natural Tangents and Cotangents

MIN	0° TAN	0° COT	1° TAN	1° COT	2° TAN	2° COT	3° TAN	3° COT	4° TAN	4° COT	
0	0.0000000	0.0000000	0.01746	57.2900	0.03492	28.6363	0.05241	19.0811	0.06993	14.3007	60
1	0.00029	3437.75	0.01775	56.3506	0.03521	28.3994	0.05270	18.9755	0.07022	14.2411	59
2	0.00058	1718.87	0.01804	55.4415	0.03550	28.1664	0.05299	18.8711	0.07051	14.1821	58
3	0.00087	1145.92	0.01833	54.5613	0.03579	27.9372	0.05328	18.7678	0.07080	14.1235	57
4	0.00116	859.436	0.01862	53.7086	0.03609	27.7117	0.05357	18.6656	0.07110	14.0655	56
5	0.00145	687.549	0.01891	52.8821	0.03638	27.4899	0.05387	18.5645	0.07139	14.0079	55
6	0.00175	572.957	0.01920	52.0807	0.03667	27.2715	0.05416	18.4645	0.07168	13.9507	54
7	0.00204	491.106	0.01949	51.3032	0.03696	27.0566	0.05445	18.3655	0.07197	13.8940	53
8	0.00233	429.718	0.01978	50.5485	0.03725	26.8450	0.05474	18.2677	0.07227	13.8378	52
9	0.00262	381.971	0.02007	49.8157	0.03754	26.6367	0.05503	18.1708	0.07256	13.7821	51
10	0.00291	343.774	0.02036	49.1039	0.03783	26.4316	0.05533	18.0750	0.07285	13.7267	50
11	0.00320	312.521	0.02066	48.4121	0.03812	26.2296	0.05562	17.9802	0.07314	13.6719	49
12	0.00349	286.478	0.02095	47.7395	0.03842	26.0307	0.05591	17.8863	0.07344	13.6174	48
13	0.00378	264.441	0.02124	47.0853	0.03871	25.8348	0.05620	17.7934	0.07373	13.5634	47
14	0.00407	245.552	0.02153	46.4489	0.03900	25.6418	0.05649	17.7015	0.07402	13.5098	46
15	0.00436	229.182	0.02182	45.8294	0.03929	25.4517	0.05678	17.6106	0.07431	13.4566	45
16	0.00465	214.858	0.02211	45.2261	0.03958	25.2644	0.05708	17.5205	0.07461	13.4039	44
17	0.00495	202.219	0.02240	44.6386	0.03987	25.0798	0.05737	17.4314	0.07490	13.3515	43
18	0.00524	190.984	0.02269	44.0661	0.04016	24.8978	0.05766	17.3432	0.07519	13.2996	42
19	0.00553	180.932	0.02298	43.5081	0.04046	24.7185	0.05795	17.2558	0.07548	13.2480	41
20	0.00582	171.885	0.02328	42.9641	0.04075	24.5418	0.05824	17.1693	0.07578	13.1969	40
21	0.00611	163.700	0.02357	42.4335	0.04104	24.3675	0.05854	17.0837	0.07607	13.1461	39
22	0.00640	156.259	0.02386	41.9158	0.04133	24.1957	0.05883	16.9990	0.07636	13.0958	38
23	0.00669	149.465	0.02415	41.4106	0.04162	24.0263	0.05912	16.9150	0.07665	13.0458	37
24	0.00698	143.237	0.02444	40.9174	0.04191	23.8593	0.05941	16.8319	0.07695	12.9962	36
25	0.00727	137.507	0.02473	40.4358	0.04220	23.6945	0.05970	16.7496	0.07724	12.9469	35
26	0.00756	132.219	0.02502	39.9655	0.04250	23.5321	0.05999	16.6681	0.07753	12.8981	34
27	0.00785	127.321	0.02531	39.5059	0.04279	23.3718	0.06029	16.5874	0.07782	12.8496	33
28	0.00815	122.774	0.02560	39.0568	0.04308	23.2137	0.06058	16.5075	0.07812	12.8014	32
29	0.00844	118.540	0.02589	38.6177	0.04337	23.0577	0.06087	16.4283	0.07841	12.7536	31
30	0.00873	114.589	0.02619	38.1885	0.04366	22.9038	0.06116	16.3499	0.07870	12.7062	30
31	0.00902	110.892	0.02648	37.7686	0.04395	22.7519	0.06145	16.2722	0.07899	12.6591	29
32	0.00931	107.426	0.02677	37.3579	0.04424	22.6020	0.06175	16.1952	0.07929	12.6124	28
33	0.00960	104.171	0.02706	36.9560	0.04454	22.4541	0.06204	16.1190	0.07958	12.5660	27
34	0.00989	101.107	0.02735	36.5627	0.04483	22.3081	0.06233	16.0435	0.07987	12.5199	26
35	0.01018	98.2179	0.02764	36.1776	0.04512	22.1640	0.06262	15.9687	0.08017	12.4742	25
36	0.01047	95.4895	0.02793	35.8006	0.04541	22.0217	0.06291	15.8945	0.08046	12.4288	24
37	0.01076	92.9085	0.02822	35.4313	0.04570	21.8813	0.06321	15.8211	0.08075	12.3838	23
38	0.01105	90.4633	0.02851	35.0695	0.04599	21.7426	0.06350	15.7483	0.08104	12.3390	22
39	0.01135	88.1436	0.02881	34.7151	0.04628	21.6056	0.06379	15.6762	0.08134	12.2946	21
40	0.01164	85.9398	0.02910	34.3678	0.04658	21.4704	0.06408	15.6048	0.08163	12.2505	20
41	0.01193	83.8435	0.02939	34.0273	0.04687	21.3369	0.06438	15.5340	0.08192	12.2067	19
42	0.01222	81.8470	0.02968	33.6935	0.04716	21.2049	0.06467	15.4638	0.08221	12.1632	18
43	0.01251	79.9434	0.02997	33.3662	0.04745	21.0747	0.06496	15.3943	0.08251	12.1201	17
44	0.01280	78.1263	0.03026	33.0452	0.04774	20.9460	0.06525	15.3254	0.08280	12.0772	16
45	0.01309	76.3900	0.03055	32.7303	0.04803	20.8188	0.06554	15.2571	0.08309	12.0346	15
46	0.01338	74.7292	0.03084	32.4213	0.04833	20.6932	0.06584	15.1893	0.08339	11.9923	14
47	0.01367	73.1390	0.03114	32.1181	0.04862	20.5691	0.06613	15.1222	0.08368	11.9504	13
48	0.01396	71.6151	0.03143	31.8205	0.04891	20.4465	0.06642	15.0557	0.08397	11.9087	12
49	0.01425	70.1533	0.03172	31.5284	0.04920	20.3253	0.06671	14.9898	0.08427	11.8673	11
50	0.01455	68.7501	0.03201	31.2416	0.04949	20.2056	0.06700	14.9244	0.08456	11.8262	10
51	0.01484	67.4019	0.03230	30.9599	0.04978	20.0872	0.06730	14.8596	0.08485	11.7853	9
52	0.01513	66.1055	0.03259	30.6833	0.05007	19.9702	0.06759	14.7954	0.08514	11.7448	8
53	0.01542	64.8580	0.03288	30.4116	0.05037	19.8546	0.06788	14.7317	0.08544	11.7045	7
54	0.01571	63.6567	0.03317	30.1446	0.05066	19.7403	0.06817	14.6685	0.08573	11.6645	6
55	0.01600	62.4992	0.03346	29.8823	0.05095	19.6273	0.06847	14.6059	0.08602	11.6248	5
56	0.01629	61.3829	0.03376	29.6245	0.05124	19.5156	0.06876	14.5438	0.08632	11.5853	4
57	0.01658	60.3058	0.03405	29.3711	0.05153	19.4051	0.06905	14.4823	0.08661	11.5461	3
58	0.01687	59.2659	0.03434	29.1220	0.05182	19.2959	0.06934	14.4212	0.08690	11.5072	2
59	0.01716	58.2612	0.03463	28.8771	0.05212	19.1879	0.06963	14.3607	0.08720	11.4685	1
60	0.01746	57.2900	0.03492	28.6363	0.05241	19.0811	0.06993	14.3007	0.08749	11.4301	0
	COT	TAN	COT	TAN	COT	TAN	COT	TAN	COT	TAN	MIN
	89°		88°		87°		86°		85°		

MIN	5° TAN	5° COT	6° TAN	6° COT	7° TAN	7° COT	8° TAN	8° COT	9° TAN	9° COT	MIN
0	0.08749	11.4301	0.10510	9.51436	0.12278	8.14435	0.14054	7.11537	0.15838	6.31375	60
1	0.08778	11.3919	0.10540	9.48781	0.12308	8.12481	0.14084	7.10038	0.15868	6.30189	59
2	0.08807	11.3540	0.10569	9.46141	0.12338	8.10536	0.14113	7.08546	0.15898	6.29007	58
3	0.08837	11.3163	0.10599	9.43515	0.12367	8.08600	0.14143	7.07059	0.15928	6.27829	57
4	0.08866	11.2789	0.10628	9.40904	0.12397	8.06674	0.14173	7.05579	0.15958	6.26655	56
5	0.08895	11.2417	0.10657	9.38307	0.12426	8.04756	0.14202	7.04105	0.15988	6.25486	55
6	0.08925	11.2048	0.10687	9.35724	0.12456	8.02848	0.14232	7.02637	0.16017	6.24321	54
7	0.08954	11.1681	0.10716	9.33155	0.12485	8.00948	0.14262	7.01174	0.16047	6.23160	53
8	0.08983	11.1316	0.10746	9.30599	0.12515	7.99058	0.14291	6.99718	0.16077	6.22003	52
9	0.09013	11.0954	0.10775	9.28058	0.12544	7.97176	0.14321	6.98268	0.16107	6.20851	51
10	0.09042	11.0594	0.10805	9.25530	0.12574	7.95302	0.14351	6.96823	0.16137	6.19703	50
11	0.09071	11.0237	0.10834	9.23016	0.12603	7.93438	0.14381	6.95385	0.16167	6.18559	49
12	0.09101	10.9882	0.10863	9.20516	0.12633	7.91582	0.14410	6.93952	0.16196	6.17419	48
13	0.09130	10.9529	0.10893	9.18028	0.12662	7.89734	0.14440	6.92525	0.16226	6.16283	47
14	0.09159	10.9178	0.10922	9.15554	0.12692	7.87895	0.14470	6.91104	0.16256	6.15151	46
15	0.09189	10.8829	0.10952	9.13093	0.12722	7.86064	0.14499	6.89688	0.16286	6.14023	45
16	0.09218	10.8483	0.10981	9.10646	0.12751	7.84242	0.14529	6.88278	0.16316	6.12899	44
17	0.09247	10.8139	0.11011	9.08211	0.12781	7.82428	0.14559	6.86874	0.16346	6.11779	43
18	0.09277	10.7797	0.11040	9.05789	0.12810	7.80622	0.14588	6.85475	0.16376	6.10664	42
19	0.09306	10.7457	0.11070	9.03379	0.12840	7.78825	0.14618	6.84082	0.16405	6.09552	41
20	0.09335	10.7119	0.11099	9.00983	0.12869	7.77035	0.14648	6.82694	0.16435	6.08444	40
21	0.09365	10.6783	0.11128	8.98598	0.12899	7.75254	0.14678	6.81312	0.16465	6.07340	39
22	0.09394	10.6450	0.11158	8.96227	0.12929	7.73480	0.14707	6.79936	0.16495	6.06240	38
23	0.09423	10.6118	0.11187	8.93867	0.12958	7.71715	0.14737	6.78564	0.16525	6.05143	37
24	0.09453	10.5789	0.11217	8.91520	0.12988	7.69957	0.14767	6.77199	0.16555	6.04051	36
25	0.09482	10.5462	0.11246	8.89185	0.13017	7.68208	0.14796	6.75838	0.16585	6.02962	35
26	0.09511	10.5136	0.11276	8.86862	0.13047	7.66466	0.14826	6.74483	0.16615	6.01878	34
27	0.09541	10.4813	0.11305	8.84551	0.13076	7.64732	0.14856	6.73133	0.16645	6.00797	33
28	0.09570	10.4491	0.11335	8.82252	0.13106	7.63005	0.14886	6.71789	0.16674	5.99720	32
29	0.09600	10.4172	0.11364	8.79964	0.13136	7.61287	0.14915	6.70450	0.16704	5.98646	31
30	0.09629	10.3854	0.11394	8.77689	0.13165	7.59575	0.14945	6.69116	0.16734	5.97576	30
31	0.09658	10.3538	0.11423	8.75425	0.13195	7.57872	0.14975	6.67787	0.16764	5.96510	29
32	0.09688	10.3224	0.11452	8.73172	0.13224	7.56176	0.15005	6.66463	0.16794	5.95448	28
33	0.09717	10.2913	0.11482	8.70931	0.13254	7.54487	0.15034	6.65144	0.16824	5.94390	27
34	0.09746	10.2602	0.11511	8.68701	0.13284	7.52806	0.15064	6.63831	0.16854	5.93335	26
35	0.09776	10.2294	0.11541	8.66482	0.13313	7.51132	0.15094	6.62523	0.16884	5.92283	25
36	0.09805	10.1988	0.11570	8.64275	0.13343	7.49465	0.15124	6.61219	0.16914	5.91236	24
37	0.09834	10.1683	0.11600	8.62078	0.13372	7.47806	0.15153	6.59921	0.16944	5.90191	23
38	0.09864	10.1381	0.11629	8.59893	0.13402	7.46154	0.15183	6.58627	0.16974	5.89151	22
39	0.09893	10.1080	0.11659	8.57718	0.13432	7.44509	0.15213	6.57339	0.17004	5.88114	21
40	0.09923	10.0780	0.11688	8.55555	0.13461	7.42871	0.15243	6.56055	0.17033	5.87080	20
41	0.09952	10.0483	0.11718	8.53402	0.13491	7.41240	0.15272	6.54777	0.17063	5.86051	19
42	0.09981	10.0187	0.11747	8.51259	0.13521	7.39616	0.15302	6.53503	0.17093	5.85024	18
43	0.10011	9.98931	0.11777	8.49128	0.13550	7.37999	0.15332	6.52234	0.17123	5.84001	17
44	0.10040	9.96007	0.11806	8.47007	0.13580	7.36389	0.15362	6.50970	0.17153	5.82982	16
45	0.10069	9.93101	0.11836	8.44896	0.13609	7.34786	0.15391	6.49710	0.17183	5.81966	15
46	0.10099	9.90211	0.11865	8.42795	0.13639	7.33190	0.15421	6.48456	0.17213	5.80953	14
47	0.10128	9.87338	0.11895	8.40705	0.13669	7.31600	0.15451	6.47206	0.17243	5.79944	13
48	0.10158	9.84482	0.11924	8.38625	0.13698	7.30018	0.15481	6.45961	0.17273	5.78938	12
49	0.10187	9.81641	0.11954	8.36555	0.13728	7.28442	0.15511	6.44720	0.17303	5.77936	11
50	0.10216	9.78817	0.11983	8.34496	0.13758	7.26873	0.15540	6.43484	0.17333	5.76937	10
51	0.10246	9.76009	0.12013	8.32446	0.13787	7.25310	0.15570	6.42253	0.17363	5.75941	9
52	0.10275	9.73217	0.12042	8.30406	0.13817	7.23754	0.15600	6.41026	0.17393	5.74949	8
53	0.10305	9.70441	0.12072	8.28376	0.13846	7.22204	0.15630	6.39804	0.17423	5.73960	7
54	0.10334	9.67680	0.12101	8.26355	0.13876	7.20661	0.15660	6.38587	0.17453	5.72974	6
55	0.10363	9.64935	0.12131	8.24345	0.13906	7.19125	0.15689	6.37374	0.17483	5.71992	5
56	0.10393	9.62205	0.12160	8.22344	0.13935	7.17594	0.15719	6.36165	0.17513	5.71013	4
57	0.10422	9.59490	0.12190	8.20352	0.13965	7.16071	0.15749	6.34961	0.17543	5.70037	3
58	0.10452	9.56791	0.12219	8.18370	0.13995	7.14553	0.15779	6.33761	0.17573	5.69064	2
59	0.10481	9.54106	0.12249	8.16398	0.14024	7.13042	0.15809	6.32566	0.17603	5.68094	1
60	0.10510	9.51436	0.12278	8.14435	0.14054	7.11537	0.15838	6.31375	0.17633	5.67128	0
MIN	84° COT	84° TAN	83° COT	83° TAN	82° COT	82° TAN	81° COT	81° TAN	80° COT	80° TAN	MIN

Table AII-2.—Natural Tangents and Cotangents—Continued

MIN	10° TAN	10° COT	11° TAN	11° COT	12° TAN	12° COT	13° TAN	13° COT	14° TAN	14° COT	MIN
0	0.17633	5.67128	0.19438	5.14455	0.21256	4.70463	0.23087	4.33148	0.24933	4.01078	60
1	0.17663	5.66165	0.19468	5.13658	0.21286	4.69791	0.23117	4.32573	0.24964	4.00582	59
2	0.17693	5.65205	0.19498	5.12862	0.21316	4.69121	0.23148	4.32001	0.24995	4.00086	58
3	0.17723	5.64248	0.19529	5.12069	0.21347	4.68452	0.23179	4.31430	0.25026	3.99592	57
4	0.17753	5.63295	0.19559	5.11279	0.21377	4.67786	0.23209	4.30860	0.25056	3.99099	56
5	0.17783	5.62344	0.19589	5.10490	0.21408	4.67121	0.23240	4.30291	0.25087	3.98607	55
6	0.17813	5.61397	0.19619	5.09704	0.21438	4.66458	0.23271	4.29724	0.25118	3.98117	54
7	0.17843	5.60452	0.19649	5.08921	0.21469	4.65797	0.23301	4.29159	0.25149	3.97627	53
8	0.17873	5.59511	0.19680	5.08139	0.21499	4.65138	0.23332	4.28595	0.25180	3.97139	52
9	0.17903	5.58573	0.19710	5.07360	0.21529	4.64480	0.23363	4.28032	0.25211	3.96651	51
10	0.17933	5.57638	0.19740	5.06584	0.21560	4.63825	0.23393	4.27471	0.25242	3.96165	50
11	0.17963	5.56706	0.19770	5.05809	0.21590	4.63171	0.23424	4.26911	0.25273	3.95680	49
12	0.17993	5.55777	0.19801	5.05037	0.21621	4.62518	0.23455	4.26352	0.25304	3.95196	48
13	0.18023	5.54851	0.19831	5.04267	0.21651	4.61868	0.23485	4.25795	0.25335	3.94713	47
14	0.18053	5.53927	0.19861	5.03499	0.21682	4.61219	0.23516	4.25239	0.25366	3.94232	46
15	0.18083	5.53007	0.19891	5.02734	0.21712	4.60572	0.23547	4.24685	0.25397	3.93751	45
16	0.18113	5.52090	0.19921	5.01971	0.21743	4.59927	0.23578	4.24132	0.25428	3.93271	44
17	0.18143	5.51176	0.19952	5.01210	0.21773	4.59283	0.23608	4.23580	0.25459	3.92793	43
18	0.18173	5.50264	0.19982	5.00451	0.21804	4.58641	0.23639	4.23030	0.25490	3.92316	42
19	0.18203	5.49356	0.20012	4.99695	0.21834	4.58001	0.23670	4.22481	0.25521	3.91839	41
20	0.18233	5.48451	0.20042	4.98940	0.21864	4.57363	0.23700	4.21933	0.25552	3.91364	40
21	0.18263	5.47548	0.20073	4.98188	0.21895	4.56726	0.23731	4.21387	0.25583	3.90890	39
22	0.18293	5.46648	0.20103	4.97438	0.21925	4.56091	0.23762	4.20842	0.25614	3.90417	38
23	0.18323	5.45751	0.20133	4.96690	0.21956	4.55458	0.23793	4.20298	0.25645	3.89945	37
24	0.18353	5.44857	0.20164	4.95945	0.21986	4.54826	0.23823	4.19756	0.25676	3.89474	36
25	0.18384	5.43966	0.20194	4.95201	0.22017	4.54196	0.23854	4.19215	0.25707	3.89004	35
26	0.18414	5.43077	0.20224	4.94460	0.22047	4.53568	0.23885	4.18675	0.25738	3.88536	34
27	0.18444	5.42192	0.20254	4.93721	0.22078	4.52941	0.23916	4.18137	0.25769	3.88068	33
28	0.18474	5.41309	0.20285	4.92984	0.22108	4.52316	0.23946	4.17600	0.25800	3.87601	32
29	0.18504	5.40429	0.20315	4.92249	0.22139	4.51693	0.23977	4.17064	0.25831	3.87136	31
30	0.18534	5.39552	0.20345	4.91516	0.22169	4.51071	0.24008	4.16530	0.25862	3.86671	30
31	0.18564	5.38677	0.20376	4.90785	0.22200	4.50451	0.24039	4.15997	0.25893	3.86208	29
32	0.18594	5.37805	0.20406	4.90056	0.22231	4.49832	0.24069	4.15465	0.25924	3.85745	28
33	0.18624	5.36936	0.20436	4.89330	0.22261	4.49215	0.24100	4.14934	0.25955	3.85284	27
34	0.18654	5.36070	0.20466	4.88605	0.22292	4.48600	0.24131	4.14405	0.25986	3.84824	26
35	0.18684	5.35206	0.20497	4.87882	0.22322	4.47986	0.24162	4.13877	0.26017	3.84364	25
36	0.18714	5.34345	0.20527	4.87162	0.22353	4.47374	0.24193	4.13350	0.26048	3.83906	24
37	0.18745	5.33487	0.20557	4.86444	0.22383	4.46764	0.24223	4.12825	0.26079	3.83449	23
38	0.18775	5.32631	0.20588	4.85727	0.22414	4.46155	0.24254	4.12301	0.26110	3.82992	22
39	0.18805	5.31778	0.20618	4.85013	0.22444	4.45548	0.24285	4.11778	0.26141	3.82537	21
40	0.18835	5.30928	0.20648	4.84300	0.22475	4.44942	0.24316	4.11256	0.26172	3.82083	20
41	0.18865	5.30080	0.20679	4.83590	0.22505	4.44338	0.24347	4.10736	0.26203	3.81630	19
42	0.18895	5.29235	0.20709	4.82882	0.22536	4.43735	0.24377	4.10216	0.26235	3.81177	18
43	0.18925	5.28393	0.20739	4.82175	0.22567	4.43134	0.24408	4.09699	0.26266	3.80726	17
44	0.18955	5.27553	0.20770	4.81471	0.22597	4.42534	0.24439	4.09182	0.26297	3.80276	16
45	0.18986	5.26715	0.20800	4.80769	0.22628	4.41936	0.24470	4.08666	0.26328	3.79827	15
46	0.19016	5.25880	0.20830	4.80068	0.22658	4.41340	0.24501	4.08152	0.26359	3.79378	14
47	0.19046	5.25048	0.20861	4.79370	0.22689	4.40745	0.24532	4.07639	0.26390	3.78931	13
48	0.19076	5.24218	0.20891	4.78673	0.22719	4.40152	0.24562	4.07127	0.26421	3.78485	12
49	0.19106	5.23391	0.20921	4.77978	0.22750	4.39560	0.24593	4.06616	0.26452	3.78040	11
50	0.19136	5.22566	0.20952	4.77286	0.22781	4.38969	0.24624	4.06107	0.26483	3.77595	10
51	0.19166	5.21744	0.20982	4.76595	0.22811	4.38381	0.24655	4.05599	0.26515	3.77152	9
52	0.19197	5.20925	0.21013	4.75906	0.22842	4.37793	0.24686	4.05092	0.26546	3.76709	8
53	0.19227	5.20107	0.21043	4.75219	0.22872	4.37207	0.24717	4.04586	0.26577	3.76268	7
54	0.19257	5.19293	0.21073	4.74534	0.22903	4.36623	0.24747	4.04081	0.26608	3.75828	6
55	0.19287	5.18480	0.21104	4.73851	0.22934	4.36040	0.24778	4.03578	0.26639	3.75388	5
56	0.19317	5.17671	0.21134	4.73170	0.22964	4.35459	0.24809	4.03076	0.26670	3.74950	4
57	0.19347	5.16863	0.21164	4.72490	0.22995	4.34879	0.24840	4.02574	0.26701	3.74512	3
58	0.19378	5.16058	0.21195	4.71813	0.23026	4.34300	0.24871	4.02074	0.26733	3.74075	2
59	0.19408	5.15256	0.21225	4.71137	0.23056	4.33723	0.24902	4.01576	0.26764	3.73640	1
60	0.19438	5.14455	0.21256	4.70463	0.23087	4.33148	0.24933	4.01078	0.26795	3.73205	0
	COT	TAN	COT	TAN	COT	TAN	COT	TAN	COT	TAN	MIN
	79°		78°		77°		76°		75°		

Table AII-2.—Natural Tangents and Cotangents—Continued

MIN	15° TAN	15° COT	16° TAN	16° COT	17° TAN	17° COT	18° TAN	18° COT	19° TAN	19° COT	MIN
0	0.26795	3.73205	0.28675	3.48741	0.30573	3.27085	0.32492	3.07768	0.34433	2.90421	60
1	0.26826	3.72771	0.28706	3.48359	0.30605	3.26745	0.32524	3.07464	0.34465	2.90147	59
2	0.26857	3.72338	0.28738	3.47977	0.30637	3.26406	0.32556	3.07160	0.34498	2.89873	58
3	0.26888	3.71907	0.28769	3.47596	0.30669	3.26067	0.32588	3.06857	0.34530	2.89600	57
4	0.26920	3.71476	0.28801	3.47216	0.30700	3.25729	0.32621	3.06554	0.34563	2.89327	56
5	0.26951	3.71046	0.28832	3.46837	0.30732	3.25392	0.32653	3.06252	0.34596	2.89055	55
6	0.26982	3.70616	0.28864	3.46458	0.30764	3.25055	0.32685	3.05950	0.34628	2.88783	54
7	0.27013	3.70188	0.28895	3.46080	0.30796	3.24719	0.32717	3.05649	0.34661	2.88511	53
8	0.27044	3.69761	0.28927	3.45703	0.30828	3.24383	0.32749	3.05349	0.34693	2.88240	52
9	0.27076	3.69335	0.28958	3.45327	0.30860	3.24049	0.32782	3.05049	0.34726	2.87970	51
10	0.27107	3.68909	0.28990	3.44951	0.30891	3.23714	0.32814	3.04749	0.34758	2.87700	50
11	0.27138	3.68485	0.29021	3.44576	0.30923	3.23381	0.32846	3.04450	0.34791	2.87430	49
12	0.27169	3.68061	0.29053	3.44202	0.30955	3.23048	0.32878	3.04152	0.34824	2.87161	48
13	0.27201	3.67638	0.29084	3.43829	0.30987	3.22715	0.32911	3.03854	0.34856	2.86892	47
14	0.27232	3.67217	0.29116	3.43456	0.31019	3.22384	0.32943	3.03556	0.34889	2.86624	46
15	0.27263	3.66796	0.29147	3.43084	0.31051	3.22053	0.32975	3.03260	0.34922	2.86356	45
16	0.27294	3.66376	0.29179	3.42713	0.31083	3.21722	0.33007	3.02963	0.34954	2.86089	44
17	0.27326	3.65957	0.29210	3.42343	0.31115	3.21392	0.33040	3.02667	0.34987	2.85822	43
18	0.27357	3.65538	0.29242	3.41973	0.31147	3.21063	0.33072	3.02372	0.35020	2.85555	42
19	0.27388	3.65121	0.29274	3.41604	0.31178	3.20734	0.33104	3.02077	0.35052	2.85289	41
20	0.27419	3.64705	0.29305	3.41236	0.31210	3.20406	0.33136	3.01783	0.35085	2.85023	40
21	0.27451	3.64289	0.29337	3.40869	0.31242	3.20079	0.33169	3.01489	0.35118	2.84758	39
22	0.27482	3.63874	0.29368	3.40502	0.31274	3.19752	0.33201	3.01196	0.35150	2.84494	38
23	0.27513	3.63461	0.29400	3.40136	0.31306	3.19426	0.33233	3.00903	0.35183	2.84229	37
24	0.27545	3.63048	0.29432	3.39771	0.31338	3.19100	0.33266	3.00611	0.35216	2.83965	36
25	0.27576	3.62636	0.29463	3.39406	0.31370	3.18775	0.33298	3.00319	0.35248	2.83702	35
26	0.27607	3.62224	0.29495	3.39042	0.31402	3.18451	0.33330	3.00028	0.35281	2.83439	34
27	0.27638	3.61814	0.29526	3.38679	0.31434	3.18127	0.33363	2.99738	0.35314	2.83176	33
28	0.27670	3.61405	0.29558	3.38317	0.31466	3.17804	0.33395	2.99447	0.35346	2.82914	32
29	0.27701	3.60996	0.29590	3.37955	0.31498	3.17481	0.33427	2.99158	0.35379	2.82653	31
30	0.27732	3.60588	0.29621	3.37594	0.31530	3.17159	0.33460	2.98868	0.35412	2.82391	30
31	0.27764	3.60181	0.29653	3.37234	0.31562	3.16838	0.33492	2.98580	0.35445	2.82130	29
32	0.27795	3.59775	0.29685	3.36875	0.31594	3.16517	0.33524	2.98292	0.35477	2.81870	28
33	0.27826	3.59370	0.29716	3.36516	0.31626	3.16197	0.33557	2.98004	0.35510	2.81610	27
34	0.27858	3.58966	0.29748	3.36158	0.31658	3.15877	0.33589	2.97717	0.35543	2.81350	26
35	0.27889	3.58562	0.29780	3.35800	0.31690	3.15558	0.33621	2.97430	0.35576	2.81091	25
36	0.27921	3.58160	0.29811	3.35443	0.31722	3.15240	0.33654	2.97144	0.35608	2.80833	24
37	0.27952	3.57758	0.29843	3.35087	0.31754	3.14922	0.33686	2.96858	0.35641	2.80574	23
38	0.27983	3.57357	0.29875	3.34732	0.31786	3.14605	0.33718	2.96573	0.35674	2.80316	22
39	0.28015	3.56957	0.29906	3.34377	0.31818	3.14288	0.33751	2.96288	0.35707	2.80059	21
40	0.28046	3.56557	0.29938	3.34023	0.31850	3.13972	0.33783	2.96004	0.35740	2.79802	20
41	0.28077	3.56159	0.29970	3.33670	0.31882	3.13656	0.33816	2.95721	0.35772	2.79545	19
42	0.28109	3.55761	0.30001	3.33317	0.31914	3.13341	0.33848	2.95437	0.35805	2.79289	18
43	0.28140	3.55364	0.30033	3.32965	0.31946	3.13027	0.33881	2.95155	0.35838	2.79033	17
44	0.28172	3.54968	0.30065	3.32614	0.31978	3.12713	0.33913	2.94872	0.35871	2.78778	16
45	0.28203	3.54573	0.30097	3.32264	0.32010	3.12400	0.33945	2.94591	0.35904	2.78523	15
46	0.28234	3.54179	0.30128	3.31914	0.32042	3.12087	0.33978	2.94309	0.35937	2.78269	14
47	0.28266	3.53785	0.30160	3.31565	0.32074	3.11775	0.34010	2.94028	0.35969	2.78014	13
48	0.28297	3.53393	0.30192	3.31216	0.32106	3.11464	0.34043	2.93748	0.36002	2.77761	12
49	0.28329	3.53001	0.30224	3.30868	0.32139	3.11153	0.34075	2.93468	0.36035	2.77507	11
50	0.28360	3.52609	0.30255	3.30521	0.32171	3.10842	0.34108	2.93189	0.36068	2.77254	10
51	0.28391	3.52219	0.30287	3.30174	0.32203	3.10532	0.34140	2.92910	0.36101	2.77002	9
52	0.28423	3.51829	0.30319	3.29829	0.32235	3.10223	0.34173	2.92632	0.36134	2.76750	8
53	0.28454	3.51441	0.30351	3.29483	0.32267	3.09914	0.34205	2.92354	0.36167	2.76498	7
54	0.28486	3.51053	0.30382	3.29139	0.32299	3.09606	0.34238	2.92076	0.36199	2.76247	6
55	0.28517	3.50666	0.30414	3.28795	0.32331	3.09298	0.34270	2.91799	0.36232	2.75996	5
56	0.28549	3.50279	0.30446	3.28452	0.32363	3.08991	0.34303	2.91523	0.36265	2.75746	4
57	0.28580	3.49894	0.30478	3.28109	0.32396	3.08685	0.34335	2.91246	0.36298	2.75496	3
58	0.28612	3.49509	0.30509	3.27767	0.32428	3.08379	0.34368	2.90971	0.36331	2.75246	2
59	0.28643	3.49125	0.30541	3.27426	0.32460	3.08073	0.34400	2.90696	0.36364	2.74997	1
60	0.28675	3.48741	0.30573	3.27085	0.32492	3.07768	0.34433	2.90421	0.36397	2.74748	0
MIN	74° COT	74° TAN	73° COT	73° TAN	72° COT	72° TAN	71° COT	71° TAN	70° COT	70° TAN	MIN

Table AII-2.—Natural Tangents and Cotangents—Continued

MIN	20° TAN	20° COT	21° TAN	21° COT	22° TAN	22° COT	23° TAN	23° COT	24° TAN	24° COT	MIN
0	0.36397	2.74748	0.38386	2.60509	0.40403	2.47509	0.42447	2.35585	0.44523	2.24604	60
1	0.36430	2.74499	0.38420	2.60283	0.40436	2.47302	0.42482	2.35395	0.44558	2.24428	59
2	0.36463	2.74251	0.38453	2.60057	0.40470	2.47095	0.42516	2.35205	0.44593	2.24252	58
3	0.36496	2.74004	0.38487	2.59831	0.40504	2.46888	0.42551	2.35015	0.44627	2.24077	57
4	0.36529	2.73756	0.38520	2.59606	0.40538	2.46682	0.42585	2.34825	0.44662	2.23902	56
5	0.36562	2.73509	0.38553	2.59381	0.40572	2.46476	0.42619	2.34636	0.44697	2.23727	55
6	0.36595	2.73263	0.38587	2.59156	0.40606	2.46270	0.42654	2.34447	0.44732	2.23553	54
7	0.36628	2.73017	0.38620	2.58932	0.40640	2.46065	0.42688	2.34258	0.44767	2.23378	53
8	0.36661	2.72771	0.38654	2.58708	0.40674	2.45860	0.42722	2.34069	0.44802	2.23204	52
9	0.36694	2.72526	0.38687	2.58484	0.40707	2.45655	0.42757	2.33881	0.44837	2.23030	51
10	0.36727	2.72281	0.38721	2.58261	0.40741	2.45451	0.42791	2.33693	0.44872	2.22857	50
11	0.36760	2.72036	0.38754	2.58038	0.40775	2.45246	0.42826	2.33505	0.44907	2.22683	49
12	0.36793	2.71792	0.38787	2.57815	0.40809	2.45043	0.42860	2.33317	0.44942	2.22510	48
13	0.36826	2.71548	0.38821	2.57593	0.40843	2.44839	0.42894	2.33130	0.44977	2.22337	47
14	0.36859	2.71305	0.38854	2.57371	0.40877	2.44636	0.42929	2.32943	0.45012	2.22164	46
15	0.36892	2.71062	0.38888	2.57150	0.40911	2.44433	0.42963	2.32756	0.45047	2.21992	45
16	0.36925	2.70819	0.38921	2.56928	0.40945	2.44230	0.42998	2.32570	0.45082	2.21819	44
17	0.36958	2.70577	0.38955	2.56707	0.40979	2.44027	0.43032	2.32383	0.45117	2.21647	43
18	0.36991	2.70335	0.38988	2.56487	0.41013	2.43825	0.43067	2.32197	0.45152	2.21475	42
19	0.37024	2.70094	0.39022	2.56266	0.41047	2.43623	0.43101	2.32012	0.45187	2.21304	41
20	0.37057	2.69853	0.39055	2.56046	0.41081	2.43422	0.43136	2.31826	0.45222	2.21132	40
21	0.37090	2.69612	0.39089	2.55827	0.41115	2.43220	0.43170	2.31641	0.45257	2.20961	39
22	0.37123	2.69371	0.39122	2.55608	0.41149	2.43019	0.43205	2.31456	0.45292	2.20790	38
23	0.37157	2.69131	0.39156	2.55389	0.41183	2.42819	0.43239	2.31271	0.45327	2.20619	37
24	0.37190	2.68892	0.39190	2.55170	0.41217	2.42618	0.43274	2.31086	0.45362	2.20449	36
25	0.37223	2.68653	0.39223	2.54952	0.41251	2.42418	0.43308	2.30902	0.45397	2.20278	35
26	0.37256	2.68414	0.39257	2.54734	0.41285	2.42218	0.43343	2.30718	0.45432	2.20108	34
27	0.37289	2.68175	0.39290	2.54516	0.41319	2.42019	0.43378	2.30534	0.45467	2.19938	33
28	0.37322	2.67937	0.39324	2.54299	0.41353	2.41819	0.43412	2.30351	0.45502	2.19769	32
29	0.37355	2.67700	0.39357	2.54082	0.41387	2.41620	0.43447	2.30167	0.45538	2.19599	31
30	0.37388	2.67462	0.39391	2.53865	0.41421	2.41421	0.43481	2.29984	0.45573	2.19430	30
31	0.37422	2.67225	0.39425	2.53648	0.41455	2.41223	0.43516	2.29801	0.45608	2.19261	29
32	0.37455	2.66989	0.39458	2.53432	0.41490	2.41025	0.43550	2.29619	0.45643	2.19092	28
33	0.37488	2.66752	0.39492	2.53217	0.41524	2.40827	0.43585	2.29437	0.45678	2.18923	27
34	0.37521	2.66516	0.39526	2.53001	0.41558	2.40629	0.43620	2.29254	0.45713	2.18755	26
35	0.37554	2.66281	0.39559	2.52786	0.41592	2.40432	0.43654	2.29073	0.45748	2.18587	25
36	0.37588	2.66046	0.39593	2.52571	0.41626	2.40235	0.43689	2.28891	0.45784	2.18419	24
37	0.37621	2.65811	0.39626	2.52357	0.41660	2.40038	0.43724	2.28710	0.45819	2.18251	23
38	0.37654	2.65576	0.39660	2.52142	0.41694	2.39841	0.43758	2.28528	0.45854	2.18084	22
39	0.37687	2.65342	0.39694	2.51929	0.41728	2.39645	0.43793	2.28348	0.45889	2.17916	21
40	0.37720	2.65109	0.39727	2.51715	0.41763	2.39449	0.43828	2.28167	0.45924	2.17749	20
41	0.37754	2.64875	0.39761	2.51502	0.41797	2.39253	0.43862	2.27987	0.45960	2.17582	19
42	0.37787	2.64642	0.39795	2.51289	0.41831	2.39058	0.43897	2.27806	0.45995	2.17416	18
43	0.37820	2.64410	0.39829	2.51076	0.41865	2.38863	0.43932	2.27626	0.46030	2.17249	17
44	0.37853	2.64177	0.39862	2.50864	0.41899	2.38668	0.43966	2.27447	0.46065	2.17083	16
45	0.37887	2.63945	0.39896	2.50652	0.41933	2.38473	0.44001	2.27267	0.46101	2.16917	15
46	0.37920	2.63714	0.39930	2.50440	0.41968	2.38279	0.44036	2.27088	0.46136	2.16751	14
47	0.37953	2.63483	0.39963	2.50229	0.42002	2.38084	0.44071	2.26909	0.46171	2.16585	13
48	0.37986	2.63252	0.39997	2.50018	0.42036	2.37891	0.44105	2.26730	0.46206	2.16420	12
49	0.38020	2.63021	0.40031	2.49807	0.42070	2.37697	0.44140	2.26552	0.46242	2.16255	11
50	0.38053	2.62791	0.40065	2.49597	0.42105	2.37504	0.44175	2.26374	0.46277	2.16090	10
51	0.38086	2.62561	0.40098	2.49386	0.42139	2.37311	0.44210	2.26196	0.46312	2.15925	9
52	0.38120	2.62332	0.40132	2.49177	0.42173	2.37118	0.44244	2.26018	0.46348	2.15760	8
53	0.38153	2.62103	0.40166	2.48967	0.42207	2.36925	0.44279	2.25840	0.46383	2.15596	7
54	0.38186	2.61874	0.40200	2.48758	0.42242	2.36733	0.44314	2.25663	0.46418	2.15432	6
55	0.38220	2.61646	0.40234	2.48549	0.42276	2.36541	0.44349	2.25486	0.46454	2.15268	5
56	0.38253	2.61418	0.40267	2.48340	0.42310	2.36349	0.44384	2.25309	0.46489	2.15104	4
57	0.38286	2.61190	0.40301	2.48132	0.42345	2.36158	0.44418	2.25132	0.46525	2.14940	3
58	0.38320	2.60963	0.40335	2.47924	0.42379	2.35967	0.44453	2.24956	0.46560	2.14777	2
59	0.38353	2.60736	0.40369	2.47716	0.42413	2.35776	0.44488	2.24780	0.46595	2.14614	1
60	0.38386	2.60509	0.40403	2.47509	0.42447	2.35585	0.44523	2.24604	0.46631	2.14451	0
MIN	COT	TAN	COT	TAN	COT	TAN	COT	TAN	COT	TAN	MIN
	69°		68°		67°		66°		65°		

Table AII-2.—Natural Tangents and Cotangents—Continued

MIN	25° TAN	25° COT	26° TAN	26° COT	27° TAN	27° COT	28° TAN	28° COT	29° TAN	29° COT	MIN
0	0.46631	2.14451	0.48773	2.05030	0.50953	1.96261	0.53171	1.88073	0.55431	1.80405	60
1	0.46666	2.14288	0.48809	2.04879	0.50989	1.96120	0.53208	1.87941	0.55469	1.80281	59
2	0.46702	2.14125	0.48845	2.04728	0.51026	1.95979	0.53246	1.87809	0.55507	1.80158	58
3	0.46737	2.13963	0.48881	2.04577	0.51063	1.95838	0.53283	1.87677	0.55545	1.80034	57
4	0.46772	2.13801	0.48917	2.04426	0.51099	1.95698	0.53320	1.87546	0.55583	1.79911	56
5	0.46808	2.13639	0.48953	2.04276	0.51136	1.95557	0.53358	1.87415	0.55621	1.79788	55
6	0.46843	2.13477	0.48989	2.04125	0.51173	1.95417	0.53395	1.87283	0.55659	1.79665	54
7	0.46879	2.13316	0.49026	2.03975	0.51209	1.95277	0.53432	1.87152	0.55697	1.79542	53
8	0.46914	2.13154	0.49062	2.03825	0.51246	1.95137	0.53470	1.87021	0.55736	1.79419	52
9	0.46950	2.12993	0.49098	2.03675	0.51283	1.94997	0.53507	1.86891	0.55774	1.79296	51
10	0.46985	2.12832	0.49134	2.03526	0.51319	1.94858	0.53545	1.86760	0.55812	1.79174	50
11	0.47021	2.12671	0.49170	2.03376	0.51356	1.94718	0.53582	1.86630	0.55850	1.79051	49
12	0.47056	2.12511	0.49206	2.03227	0.51393	1.94579	0.53620	1.86499	0.55888	1.78929	48
13	0.47092	2.12350	0.49242	2.03078	0.51430	1.94440	0.53657	1.86369	0.55926	1.78807	47
14	0.47128	2.12190	0.49278	2.02929	0.51467	1.94301	0.53694	1.86239	0.55964	1.78685	46
15	0.47163	2.12030	0.49315	2.02780	0.51503	1.94162	0.53732	1.86109	0.56003	1.78563	45
16	0.47199	2.11871	0.49351	2.02631	0.51540	1.94023	0.53769	1.85979	0.56041	1.78441	44
17	0.47234	2.11711	0.49387	2.02483	0.51577	1.93885	0.53807	1.85850	0.56079	1.78319	43
18	0.47270	2.11552	0.49423	2.02335	0.51614	1.93746	0.53844	1.85720	0.56117	1.78198	42
19	0.47305	2.11392	0.49459	2.02187	0.51651	1.93608	0.53882	1.85591	0.56156	1.78077	41
20	0.47341	2.11233	0.49495	2.02039	0.51688	1.93470	0.53920	1.85462	0.56194	1.77955	40
21	0.47377	2.11075	0.49532	2.01891	0.51724	1.93332	0.53957	1.85333	0.56232	1.77834	39
22	0.47412	2.10916	0.49568	2.01743	0.51761	1.93195	0.53995	1.85204	0.56270	1.77713	38
23	0.47448	2.10758	0.49604	2.01596	0.51798	1.93057	0.54032	1.85075	0.56309	1.77592	37
24	0.47483	2.10600	0.49640	2.01449	0.51835	1.92920	0.54070	1.84946	0.56347	1.77471	36
25	0.47519	2.10442	0.49677	2.01302	0.51872	1.92782	0.54107	1.84818	0.56385	1.77351	35
26	0.47555	2.10284	0.49713	2.01155	0.51909	1.92645	0.54145	1.84689	0.56424	1.77230	34
27	0.47590	2.10126	0.49749	2.01008	0.51946	1.92508	0.54183	1.84561	0.56462	1.77110	33
28	0.47626	2.09969	0.49786	2.00862	0.51983	1.92371	0.54220	1.84433	0.56501	1.76990	32
29	0.47662	2.09811	0.49822	2.00715	0.52020	1.92235	0.54258	1.84305	0.56539	1.76869	31
30	0.47698	2.09654	0.49858	2.00569	0.52057	1.92098	0.54296	1.84177	0.56577	1.76749	30
31	0.47733	2.09498	0.49894	2.00423	0.52094	1.91962	0.54333	1.84049	0.56616	1.76629	29
32	0.47769	2.09341	0.49931	2.00277	0.52131	1.91826	0.54371	1.83922	0.56654	1.76510	28
33	0.47805	2.09184	0.49967	2.00131	0.52168	1.91690	0.54409	1.83794	0.56693	1.76390	27
34	0.47840	2.09028	0.50004	1.99986	0.52205	1.91554	0.54446	1.83667	0.56731	1.76271	26
35	0.47876	2.08872	0.50040	1.99841	0.52242	1.91418	0.54484	1.83540	0.56769	1.76151	25
36	0.47912	2.08716	0.50076	1.99695	0.52279	1.91282	0.54522	1.83413	0.56808	1.76032	24
37	0.47948	2.08560	0.50113	1.99550	0.52316	1.91147	0.54560	1.83286	0.56846	1.75913	23
38	0.47984	2.08405	0.50149	1.99406	0.52353	1.91012	0.54597	1.83159	0.56885	1.75794	22
39	0.48019	2.08250	0.50185	1.99261	0.52390	1.90876	0.54635	1.83033	0.56923	1.75675	21
40	0.48055	2.08094	0.50222	1.99116	0.52427	1.90741	0.54673	1.82906	0.56962	1.75556	20
41	0.48091	2.07939	0.50258	1.98972	0.52464	1.90607	0.54711	1.82780	0.57000	1.75437	19
42	0.48127	2.07785	0.50295	1.98828	0.52501	1.90472	0.54748	1.82654	0.57039	1.75319	18
43	0.48163	2.07630	0.50331	1.98684	0.52538	1.90337	0.54786	1.82528	0.57078	1.75200	17
44	0.48198	2.07476	0.50368	1.98540	0.52575	1.90203	0.54824	1.82402	0.57116	1.75082	16
45	0.48234	2.07321	0.50404	1.98396	0.52613	1.90069	0.54862	1.82276	0.57155	1.74964	15
46	0.48270	2.07167	0.50441	1.98253	0.52650	1.89935	0.54900	1.82150	0.57193	1.74846	14
47	0.48306	2.07014	0.50477	1.98110	0.52687	1.89801	0.54938	1.82025	0.57232	1.74728	13
48	0.48342	2.06860	0.50514	1.97966	0.52724	1.89667	0.54975	1.81899	0.57271	1.74610	12
49	0.48378	2.06706	0.50550	1.97823	0.52761	1.89533	0.55013	1.81774	0.57309	1.74492	11
50	0.48414	2.06553	0.50587	1.97681	0.52798	1.89400	0.55051	1.81649	0.57348	1.74375	10
51	0.48450	2.06400	0.50623	1.97538	0.52836	1.89266	0.55089	1.81524	0.57386	1.74257	9
52	0.48486	2.06247	0.50660	1.97395	0.52873	1.89133	0.55127	1.81399	0.57425	1.74140	8
53	0.48521	2.06094	0.50696	1.97253	0.52910	1.89000	0.55165	1.81274	0.57464	1.74022	7
54	0.48557	2.05942	0.50733	1.97111	0.52947	1.88867	0.55203	1.81150	0.57503	1.73905	6
55	0.48593	2.05790	0.50769	1.96969	0.52985	1.88734	0.55241	1.81025	0.57541	1.73788	5
56	0.48629	2.05637	0.50806	1.96827	0.53022	1.88602	0.55279	1.80901	0.57580	1.73671	4
57	0.48665	2.05485	0.50843	1.96685	0.53059	1.88469	0.55317	1.80777	0.57619	1.73555	3
58	0.48701	2.05333	0.50879	1.96544	0.53096	1.88337	0.55355	1.80653	0.57657	1.73438	2
59	0.48737	2.05182	0.50916	1.96402	0.53134	1.88205	0.55393	1.80529	0.57696	1.73321	1
60	0.48773	2.05030	0.50953	1.96261	0.53171	1.88073	0.55431	1.80405	0.57735	1.73205	0
	COT	TAN	COT	TAN	COT	TAN	COT	TAN	COT	TAN	MIN
	64°		63°		62°		61°		60°		

Table AII-2.—Natural Tangents and Cotangents—Continued

MIN	30° TAN	30° COT	31° TAN	31° COT	32° TAN	32° COT	33° TAN	33° COT	34° TAN	34° COT	
0	0.57735	1.73205	0.60086	1.66428	0.62487	1.60033	0.64941	1.53986	0.67451	1.48256	60
1	0.57774	1.73089	0.60126	1.66318	0.62527	1.59930	0.64982	1.53888	0.67493	1.48163	59
2	0.57813	1.72973	0.60165	1.66209	0.62568	1.59826	0.65024	1.53791	0.67536	1.48070	58
3	0.57851	1.72857	0.60205	1.66099	0.62608	1.59723	0.65065	1.53693	0.67578	1.47977	57
4	0.57890	1.72741	0.60245	1.65990	0.62649	1.59620	0.65106	1.53595	0.67620	1.47885	56
5	0.57929	1.72625	0.60284	1.65881	0.62689	1.59517	0.65148	1.53497	0.67663	1.47792	55
6	0.57968	1.72509	0.60324	1.65772	0.62730	1.59414	0.65189	1.53400	0.67705	1.47699	54
7	0.58007	1.72393	0.60364	1.65663	0.62770	1.59311	0.65231	1.53302	0.67748	1.47607	53
8	0.58046	1.72278	0.60403	1.65554	0.62811	1.59208	0.65272	1.53205	0.67790	1.47514	52
9	0.58085	1.72163	0.60443	1.65445	0.62852	1.59105	0.65314	1.53107	0.67832	1.47422	51
10	0.58124	1.72047	0.60483	1.65337	0.62892	1.59002	0.65355	1.53010	0.67875	1.47330	50
11	0.58162	1.71932	0.60522	1.65228	0.62933	1.58900	0.65397	1.52913	0.67917	1.47238	49
12	0.58201	1.71817	0.60562	1.65120	0.62973	1.58797	0.65438	1.52816	0.67960	1.47146	48
13	0.58240	1.71702	0.60602	1.65011	0.63014	1.58695	0.65480	1.52719	0.68002	1.47053	47
14	0.58279	1.71588	0.60642	1.64903	0.63055	1.58593	0.65521	1.52622	0.68045	1.46962	46
15	0.58318	1.71473	0.60681	1.64795	0.63095	1.58490	0.65563	1.52525	0.68088	1.46870	45
16	0.58357	1.71358	0.60721	1.64687	0.63136	1.58388	0.65604	1.52429	0.68130	1.46778	44
17	0.58396	1.71244	0.60761	1.64579	0.63177	1.58286	0.65646	1.52332	0.68173	1.46686	43
18	0.58435	1.71129	0.60801	1.64471	0.63217	1.58184	0.65688	1.52235	0.68215	1.46595	42
19	0.58474	1.71015	0.60841	1.64363	0.63258	1.58083	0.65729	1.52139	0.68258	1.46503	41
20	0.58513	1.70901	0.60881	1.64256	0.63299	1.57981	0.65771	1.52043	0.68301	1.46411	40
21	0.58552	1.70787	0.60921	1.64148	0.63340	1.57879	0.65813	1.51946	0.68343	1.46320	39
22	0.58591	1.70673	0.60960	1.64041	0.63380	1.57778	0.65854	1.51850	0.68386	1.46229	38
23	0.58631	1.70560	0.61000	1.63934	0.63421	1.57676	0.65896	1.51754	0.68429	1.46137	37
24	0.58670	1.70446	0.61040	1.63826	0.63462	1.57575	0.65938	1.51658	0.68471	1.46046	36
25	0.58709	1.70332	0.61080	1.63719	0.63503	1.57474	0.65980	1.51562	0.68514	1.45955	35
26	0.58748	1.70219	0.61120	1.63612	0.63544	1.57372	0.66021	1.51466	0.68557	1.45864	34
27	0.58787	1.70106	0.61160	1.63505	0.63584	1.57271	0.66063	1.51370	0.68600	1.45773	33
28	0.58826	1.69992	0.61200	1.63398	0.63625	1.57170	0.66105	1.51275	0.68642	1.45682	32
29	0.58865	1.69879	0.61240	1.63292	0.63666	1.57069	0.66147	1.51179	0.68685	1.45592	31
30	0.58905	1.69766	0.61280	1.63185	0.63707	1.56969	0.66189	1.51084	0.68728	1.45501	30
31	0.58944	1.69653	0.61320	1.63079	0.63748	1.56868	0.66230	1.50988	0.68771	1.45410	29
32	0.58983	1.69541	0.61360	1.62972	0.63789	1.56767	0.66272	1.50893	0.68814	1.45320	28
33	0.59022	1.69428	0.61400	1.62866	0.63830	1.56667	0.66314	1.50797	0.68857	1.45229	27
34	0.59061	1.69316	0.61440	1.62760	0.63871	1.56566	0.66356	1.50702	0.68900	1.45139	26
35	0.59101	1.69203	0.61480	1.62654	0.63912	1.56466	0.66398	1.50607	0.68942	1.45049	25
36	0.59140	1.69091	0.61520	1.62548	0.63953	1.56366	0.66440	1.50512	0.68985	1.44958	24
37	0.59179	1.68979	0.61561	1.62442	0.63994	1.56265	0.66482	1.50417	0.69028	1.44868	23
38	0.59218	1.68866	0.61601	1.62336	0.64035	1.56165	0.66524	1.50322	0.69071	1.44778	22
39	0.59258	1.68754	0.61641	1.62230	0.64076	1.56065	0.66566	1.50228	0.69114	1.44688	21
40	0.59297	1.68643	0.61681	1.62125	0.64117	1.55966	0.66608	1.50133	0.69157	1.44598	20
41	0.59336	1.68531	0.61721	1.62019	0.64158	1.55866	0.66650	1.50038	0.69200	1.44508	19
42	0.59376	1.68419	0.61761	1.61914	0.64199	1.55766	0.66692	1.49944	0.69243	1.44418	18
43	0.59415	1.68308	0.61801	1.61808	0.64240	1.55666	0.66734	1.49849	0.69286	1.44329	17
44	0.59454	1.68196	0.61842	1.61703	0.64281	1.55567	0.66776	1.49755	0.69329	1.44239	16
45	0.59494	1.68085	0.61882	1.61598	0.64322	1.55467	0.66818	1.49661	0.69372	1.44149	15
46	0.59533	1.67974	0.61922	1.61493	0.64363	1.55368	0.66860	1.49566	0.69416	1.44060	14
47	0.59573	1.67863	0.61962	1.61388	0.64404	1.55269	0.66902	1.49472	0.69459	1.43970	13
48	0.59612	1.67752	0.62003	1.61283	0.64446	1.55170	0.66944	1.49378	0.69502	1.43881	12
49	0.59651	1.67641	0.62043	1.61179	0.64487	1.55071	0.66986	1.49284	0.69545	1.43792	11
50	0.59691	1.67530	0.62083	1.61074	0.64528	1.54972	0.67028	1.49190	0.69588	1.43703	10
51	0.59730	1.67419	0.62124	1.60970	0.64569	1.54873	0.67071	1.49097	0.69631	1.43614	9
52	0.59770	1.67309	0.62164	1.60865	0.64610	1.54774	0.67113	1.49003	0.69675	1.43525	8
53	0.59809	1.67198	0.62204	1.60761	0.64652	1.54675	0.67155	1.48909	0.69718	1.43436	7
54	0.59849	1.67088	0.62245	1.60657	0.64693	1.54576	0.67197	1.48816	0.69761	1.43347	6
55	0.59888	1.66978	0.62285	1.60553	0.64734	1.54478	0.67239	1.48722	0.69804	1.43258	5
56	0.59928	1.66867	0.62325	1.60449	0.64775	1.54379	0.67282	1.48629	0.69847	1.43169	4
57	0.59967	1.66757	0.62366	1.60345	0.64817	1.54281	0.67324	1.48536	0.69891	1.43080	3
58	0.60007	1.66647	0.62406	1.60241	0.64858	1.54183	0.67366	1.48442	0.69934	1.42992	2
59	0.60046	1.66538	0.62446	1.60137	0.64899	1.54085	0.67409	1.48349	0.69977	1.42903	1
60	0.60086	1.66428	0.62487	1.60033	0.64941	1.53986	0.67451	1.48256	0.70021	1.42815	0
	COT	TAN	COT	TAN	COT	TAN	COT	TAN	COT	TAN	MIN
	59°		58°		57°		56°		55°		

Table AII-2.—Natural Tangents and Cotangents—Continued

MIN	35° TAN	35° COT	36° TAN	36° COT	37° TAN	37° COT	38° TAN	38° COT	39° TAN	39° COT	MIN
0	0.70021	1.42815	0.72654	1.37638	0.75355	1.32704	0.78129	1.27994	0.80978	1.23490	60
1	0.70064	1.42726	0.72699	1.37554	0.75401	1.32624	0.78175	1.27917	0.81027	1.23416	59
2	0.70107	1.42638	0.72743	1.37470	0.75447	1.32544	0.78222	1.27841	0.81075	1.23343	58
3	0.70151	1.42550	0.72788	1.37386	0.75492	1.32464	0.78269	1.27764	0.81123	1.23270	57
4	0.70194	1.42462	0.72832	1.37302	0.75538	1.32384	0.78316	1.27688	0.81171	1.23196	56
5	0.70238	1.42374	0.72877	1.37218	0.75584	1.32304	0.78363	1.27611	0.81220	1.23123	55
6	0.70281	1.42286	0.72921	1.37134	0.75629	1.32224	0.78410	1.27535	0.81268	1.23050	54
7	0.70325	1.42198	0.72966	1.37050	0.75675	1.32144	0.78457	1.27458	0.81316	1.22977	53
8	0.70368	1.42110	0.73010	1.36967	0.75721	1.32064	0.78504	1.27382	0.81364	1.22904	52
9	0.70412	1.42022	0.73055	1.36883	0.75767	1.31984	0.78551	1.27306	0.81413	1.22831	51
10	0.70455	1.41934	0.73100	1.36800	0.75812	1.31904	0.78598	1.27230	0.81461	1.22758	50
11	0.70499	1.41847	0.73144	1.36716	0.75858	1.31825	0.78645	1.27153	0.81510	1.22685	49
12	0.70542	1.41759	0.73189	1.36633	0.75904	1.31745	0.78692	1.27077	0.81558	1.22612	48
13	0.70586	1.41672	0.73234	1.36549	0.75950	1.31666	0.78739	1.27001	0.81606	1.22539	47
14	0.70629	1.41584	0.73278	1.36466	0.75996	1.31586	0.78786	1.26925	0.81655	1.22467	46
15	0.70673	1.41497	0.73323	1.36383	0.76042	1.31507	0.78834	1.26849	0.81703	1.22394	45
16	0.70717	1.41409	0.73368	1.36300	0.76088	1.31427	0.78881	1.26774	0.81752	1.22321	44
17	0.70760	1.41322	0.73413	1.36217	0.76134	1.31348	0.78928	1.26698	0.81800	1.22249	43
18	0.70804	1.41235	0.73457	1.36134	0.76180	1.31269	0.78975	1.26622	0.81849	1.22176	42
19	0.70848	1.41148	0.73502	1.36051	0.76226	1.31190	0.79022	1.26546	0.81898	1.22104	41
20	0.70891	1.41061	0.73547	1.35968	0.76272	1.31110	0.79070	1.26471	0.81946	1.22031	40
21	0.70935	1.40974	0.73592	1.35885	0.76318	1.31031	0.79117	1.26395	0.81995	1.21959	39
22	0.70979	1.40887	0.73637	1.35802	0.76364	1.30952	0.79164	1.26319	0.82044	1.21886	38
23	0.71023	1.40800	0.73681	1.35719	0.76410	1.30873	0.79212	1.26244	0.82092	1.21814	37
24	0.71066	1.40714	0.73726	1.35637	0.76456	1.30795	0.79259	1.26169	0.82141	1.21742	36
25	0.71110	1.40627	0.73771	1.35554	0.76502	1.30716	0.79306	1.26093	0.82190	1.21670	35
26	0.71154	1.40540	0.73816	1.35472	0.76548	1.30637	0.79354	1.26018	0.82238	1.21598	34
27	0.71198	1.40454	0.73861	1.35389	0.76594	1.30558	0.79401	1.25943	0.82287	1.21526	33
28	0.71242	1.40367	0.73906	1.35307	0.76640	1.30480	0.79449	1.25867	0.82336	1.21454	32
29	0.71285	1.40281	0.73951	1.35224	0.76686	1.30401	0.79496	1.25792	0.82385	1.21382	31
30	0.71329	1.40195	0.73996	1.35142	0.76733	1.30323	0.79544	1.25717	0.82434	1.21310	30
31	0.71373	1.40109	0.74041	1.35060	0.76779	1.30244	0.79591	1.25642	0.82483	1.21238	29
32	0.71417	1.40022	0.74086	1.34978	0.76825	1.30166	0.79639	1.25567	0.82531	1.21166	28
33	0.71461	1.39936	0.74131	1.34896	0.76871	1.30087	0.79686	1.25492	0.82580	1.21094	27
34	0.71505	1.39850	0.74176	1.34814	0.76918	1.30009	0.79734	1.25417	0.82629	1.21023	26
35	0.71549	1.39764	0.74221	1.34732	0.76964	1.29931	0.79781	1.25343	0.82678	1.20951	25
36	0.71593	1.39679	0.74267	1.34650	0.77010	1.29853	0.79829	1.25268	0.82727	1.20879	24
37	0.71637	1.39593	0.74312	1.34568	0.77057	1.29775	0.79877	1.25193	0.82776	1.20808	23
38	0.71681	1.39507	0.74357	1.34487	0.77103	1.29696	0.79924	1.25118	0.82825	1.20736	22
39	0.71725	1.39421	0.74402	1.34405	0.77149	1.29618	0.79972	1.25044	0.82874	1.20665	21
40	0.71769	1.39336	0.74447	1.34323	0.77196	1.29541	0.80020	1.24969	0.82923	1.20593	20
41	0.71813	1.39250	0.74492	1.34242	0.77242	1.29463	0.80067	1.24895	0.82972	1.20522	19
42	0.71857	1.39165	0.74538	1.34160	0.77289	1.29385	0.80115	1.24820	0.83022	1.20451	18
43	0.71901	1.39079	0.74583	1.34079	0.77335	1.29307	0.80163	1.24746	0.83071	1.20379	17
44	0.71946	1.38994	0.74628	1.33998	0.77382	1.29229	0.80211	1.24672	0.83120	1.20308	16
45	0.71990	1.38909	0.74674	1.33916	0.77428	1.29152	0.80258	1.24597	0.83169	1.20237	15
46	0.72034	1.38824	0.74719	1.33835	0.77475	1.29074	0.80306	1.24523	0.83218	1.20166	14
47	0.72078	1.38738	0.74764	1.33754	0.77521	1.28997	0.80354	1.24449	0.83268	1.20095	13
48	0.72122	1.38653	0.74810	1.33673	0.77568	1.28919	0.80402	1.24375	0.83317	1.20024	12
49	0.72167	1.38568	0.74855	1.33592	0.77615	1.28842	0.80450	1.24301	0.83366	1.19953	11
50	0.72211	1.38484	0.74900	1.33511	0.77661	1.28764	0.80498	1.24227	0.83415	1.19882	10
51	0.72255	1.38399	0.74946	1.33430	0.77708	1.28687	0.80546	1.24153	0.83465	1.19811	9
52	0.72299	1.38314	0.74991	1.33349	0.77754	1.28610	0.80594	1.24079	0.83514	1.19740	8
53	0.72344	1.38229	0.75037	1.33268	0.77801	1.28533	0.80642	1.24005	0.83564	1.19669	7
54	0.72388	1.38145	0.75082	1.33187	0.77848	1.28456	0.80690	1.23931	0.83613	1.19599	6
55	0.72432	1.38060	0.75128	1.33107	0.77895	1.28379	0.80738	1.23858	0.83662	1.19528	5
56	0.72477	1.37976	0.75173	1.33026	0.77941	1.28302	0.80786	1.23784	0.83712	1.19457	4
57	0.72521	1.37891	0.75219	1.32946	0.77988	1.28225	0.80834	1.23710	0.83761	1.19387	3
58	0.72565	1.37807	0.75264	1.32865	0.78035	1.28148	0.80882	1.23637	0.83811	1.19316	2
59	0.72610	1.37722	0.75310	1.32785	0.78082	1.28071	0.80930	1.23563	0.83860	1.19246	1
60	0.72654	1.37638	0.75355	1.32704	0.78129	1.27994	0.80978	1.23490	0.83910	1.19175	0
	COT	TAN	COT	TAN	COT	TAN	COT	TAN	COT	TAN	MIN
	54°		53°		52°		51°		50°		

Table AII-2.—Natural Tangents and Cotangents—Continued

MIN	40° TAN	40° COT	41° TAN	41° COT	42° TAN	42° COT	43° TAN	43° COT	44° TAN	44° COT	MIN
0	0.83910	1.19175	0.86929	1.15037	0.90040	1.11061	0.93252	1.07237	0.96569	1.03553	60
1	0.83960	1.19105	0.86980	1.14969	0.90093	1.10996	0.93306	1.07174	0.96625	1.03493	59
2	0.84009	1.19035	0.87031	1.14902	0.90146	1.10931	0.93360	1.07112	0.96681	1.03433	58
3	0.84059	1.18964	0.87082	1.14834	0.90199	1.10867	0.93415	1.07049	0.96738	1.03372	57
4	0.84108	1.18894	0.87133	1.14767	0.90251	1.10802	0.93469	1.06987	0.96794	1.03312	56
5	0.84158	1.18824	0.87184	1.14699	0.90304	1.10737	0.93524	1.06925	0.96850	1.03252	55
6	0.84208	1.18754	0.87236	1.14632	0.90357	1.10672	0.93578	1.06862	0.96907	1.03192	54
7	0.84258	1.18684	0.87287	1.14565	0.90410	1.10607	0.93633	1.06800	0.96963	1.03132	53
8	0.84307	1.18614	0.87338	1.14498	0.90463	1.10543	0.93688	1.06738	0.97020	1.03072	52
9	0.84357	1.18544	0.87389	1.14430	0.90516	1.10478	0.93742	1.06676	0.97076	1.03012	51
10	0.84407	1.18474	0.87441	1.14363	0.90569	1.10414	0.93797	1.06613	0.97133	1.02952	50
11	0.84457	1.18404	0.87492	1.14296	0.90621	1.10349	0.93852	1.06551	0.97189	1.02892	49
12	0.84507	1.18334	0.87543	1.14229	0.90674	1.10285	0.93906	1.06489	0.97246	1.02832	48
13	0.84556	1.18264	0.87595	1.14162	0.90727	1.10220	0.93961	1.06427	0.97302	1.02772	47
14	0.84606	1.18194	0.87646	1.14095	0.90781	1.10156	0.94016	1.06365	0.97359	1.02713	46
15	0.84656	1.18125	0.87698	1.14028	0.90834	1.10091	0.94071	1.06303	0.97416	1.02653	45
16	0.84706	1.18055	0.87749	1.13961	0.90887	1.10027	0.94125	1.06241	0.97472	1.02593	44
17	0.84756	1.17986	0.87801	1.13894	0.90940	1.09963	0.94180	1.06179	0.97529	1.02533	43
18	0.84806	1.17916	0.87852	1.13828	0.90993	1.09899	0.94235	1.06117	0.97586	1.02474	42
19	0.84856	1.17846	0.87904	1.13761	0.91046	1.09834	0.94290	1.06056	0.97643	1.02414	41
20	0.84906	1.17777	0.87955	1.13694	0.91099	1.09770	0.94345	1.05994	0.97700	1.02355	40
21	0.84956	1.17708	0.88007	1.13627	0.91153	1.09706	0.94400	1.05932	0.97756	1.02295	39
22	0.85006	1.17638	0.88059	1.13561	0.91206	1.09642	0.94455	1.05870	0.97813	1.02236	38
23	0.85057	1.17569	0.88110	1.13494	0.91259	1.09578	0.94510	1.05809	0.97870	1.02176	37
24	0.85107	1.17500	0.88162	1.13428	0.91313	1.09514	0.94565	1.05747	0.97927	1.02117	36
25	0.85157	1.17430	0.88214	1.13361	0.91366	1.09450	0.94620	1.05685	0.97984	1.02057	35
26	0.85207	1.17361	0.88265	1.13295	0.91419	1.09386	0.94676	1.05624	0.98041	1.01998	34
27	0.85257	1.17292	0.88317	1.13228	0.91473	1.09322	0.94731	1.05562	0.98098	1.01939	33
28	0.85308	1.17223	0.88369	1.13162	0.91526	1.09258	0.94786	1.05501	0.98155	1.01879	32
29	0.85358	1.17154	0.88421	1.13096	0.91580	1.09195	0.94841	1.05439	0.98213	1.01820	31
30	0.85408	1.17085	0.88473	1.13029	0.91633	1.09131	0.94896	1.05378	0.98270	1.01761	30
31	0.85458	1.17016	0.88524	1.12963	0.91687	1.09067	0.94952	1.05317	0.98327	1.01702	29
32	0.85509	1.16947	0.88576	1.12897	0.91740	1.09003	0.95007	1.05255	0.98384	1.01642	28
33	0.85559	1.16878	0.88628	1.12831	0.91794	1.08940	0.95062	1.05194	0.98441	1.01583	27
34	0.85609	1.16809	0.88680	1.12765	0.91847	1.08876	0.95118	1.05133	0.98499	1.01524	26
35	0.85660	1.16741	0.88732	1.12699	0.91901	1.08813	0.95173	1.05072	0.98556	1.01465	25
36	0.85710	1.16672	0.88784	1.12633	0.91955	1.08749	0.95229	1.05010	0.98613	1.01406	24
37	0.85761	1.16603	0.88836	1.12567	0.92008	1.08686	0.95284	1.04949	0.98671	1.01347	23
38	0.85811	1.16535	0.88888	1.12501	0.92062	1.08622	0.95340	1.04888	0.98728	1.01288	22
39	0.85862	1.16466	0.88940	1.12435	0.92116	1.08559	0.95395	1.04827	0.98786	1.01229	21
40	0.85912	1.16398	0.88992	1.12369	0.92170	1.08496	0.95451	1.04766	0.98843	1.01170	20
41	0.85963	1.16329	0.89045	1.12303	0.92224	1.08432	0.95506	1.04705	0.98901	1.01112	19
42	0.86014	1.16261	0.89097	1.12238	0.92277	1.08369	0.95562	1.04644	0.98958	1.01053	18
43	0.86064	1.16192	0.89149	1.12172	0.92331	1.08306	0.95618	1.04583	0.99016	1.00994	17
44	0.86115	1.16124	0.89201	1.12106	0.92385	1.08243	0.95673	1.04522	0.99073	1.00935	16
45	0.86166	1.16056	0.89253	1.12041	0.92439	1.08179	0.95729	1.04461	0.99131	1.00876	15
46	0.86216	1.15987	0.89306	1.11975	0.92493	1.08116	0.95785	1.04401	0.99189	1.00818	14
47	0.86267	1.15919	0.89358	1.11909	0.92547	1.08053	0.95841	1.04340	0.99247	1.00759	13
48	0.86318	1.15851	0.89410	1.11844	0.92601	1.07990	0.95897	1.04279	0.99304	1.00701	12
49	0.86368	1.15783	0.89463	1.11778	0.92655	1.07927	0.95952	1.04218	0.99362	1.00642	11
50	0.86419	1.15715	0.89515	1.11713	0.92709	1.07864	0.96008	1.04158	0.99420	1.00583	10
51	0.86470	1.15647	0.89567	1.11648	0.92763	1.07801	0.96064	1.04097	0.99478	1.00525	9
52	0.86521	1.15579	0.89620	1.11582	0.92817	1.07738	0.96120	1.04036	0.99536	1.00467	8
53	0.86572	1.15511	0.89672	1.11517	0.92872	1.07676	0.96176	1.03976	0.99594	1.00408	7
54	0.86623	1.15443	0.89725	1.11452	0.92926	1.07613	0.96232	1.03915	0.99652	1.00350	6
55	0.86674	1.15375	0.89777	1.11387	0.92980	1.07550	0.96288	1.03855	0.99710	1.00291	5
56	0.86725	1.15308	0.89830	1.11321	0.93034	1.07487	0.96344	1.03794	0.99768	1.00233	4
57	0.86776	1.15240	0.89883	1.11256	0.93088	1.07425	0.96400	1.03734	0.99826	1.00175	3
58	0.86827	1.15172	0.89935	1.11191	0.93143	1.07362	0.96457	1.03674	0.99884	1.00116	2
59	0.86878	1.15104	0.89988	1.11126	0.93197	1.07299	0.96513	1.03613	0.99942	1.00058	1
60	0.86929	1.15037	0.90040	1.11061	0.93252	1.07237	0.96569	1.03553	1.00000	1.00000	0
	COT	TAN	COT	TAN	COT	TAN	COT	TAN	COT	TAN	MIN
	49°		48°		47°		46°		45°		

Table AII-3.—Stadia Reduction

Minutes	0°		1°		2°		3°	
	Hor. dist.	Diff. elev.	Hor. dist.	Diff. elev.	Hor. dist.	Diff. elev.	Hor. dist.	Diff. elev.
0	100.00	0.00	99.97	1.74	99.88	3.49	99.73	5.23
2	100.00	0.06	99.97	1.80	99.87	3.55	99.72	5.28
4	100.00	0.12	99.97	1.86	99.87	3.60	99.71	5.34
6	100.00	0.17	99.96	1.92	99.87	3.66	99.71	5.40
8	100.00	0.23	99.96	1.98	99.86	3.72	99.70	5.46
10	100.00	0.29	99.96	2.04	99.86	3.78	99.69	5.52
12	100.00	0.35	99.96	2.09	99.85	3.84	99.69	5.57
14	100.00	0.41	99.95	2.15	99.85	3.90	99.68	5.63
16	100.00	0.47	99.95	2.21	99.84	3.95	99.68	5.69
18	100.00	0.52	99.95	2.27	99.84	4.01	99.67	5.75
20	100.00	0.58	99.95	2.33	99.83	4.07	99.66	5.80
22	100.00	0.64	99.94	2.38	99.83	4.13	99.66	5.86
24	100.00	0.70	99.94	2.44	99.82	4.18	99.65	5.92
26	99.99	0.76	99.94	2.50	99.82	4.24	99.64	5.98
28	99.99	0.81	99.93	2.56	99.81	4.30	99.63	6.04
30	99.99	0.87	99.93	2.62	99.81	4.36	99.63	6.09
32	99.99	0.93	99.93	2.67	99.80	4.42	99.62	6.15
34	99.99	0.99	99.93	2.73	99.80	4.48	99.62	6.21
36	99.99	1.05	99.92	2.79	99.79	4.53	99.61	6.27
38	99.99	1.11	99.92	2.85	99.79	4.59	99.60	6.33
40	99.99	1.16	99.92	2.91	99.78	4.65	99.59	6.38
42	99.99	1.22	99.91	2.97	99.78	4.71	99.59	6.44
44	99.98	1.28	99.91	3.02	99.77	4.76	99.58	6.50
46	99.98	1.34	99.90	3.08	99.77	4.82	99.57	6.56
48	99.98	1.40	99.90	3.14	99.76	4.88	99.56	6.61
50	99.98	1.45	99.90	3.20	99.76	4.94	99.56	6.67
52	99.98	1.51	99.89	3.26	99.75	4.99	99.55	6.73
54	99.98	1.57	99.89	3.31	99.74	5.05	99.54	6.78
56	99.97	1.63	99.89	3.37	99.74	5.11	99.53	6.84
58	99.97	1.69	99.88	3.43	99.73	5.17	99.52	6.90
60	99.97	1.74	99.88	3.49	99.73	5.23	99.51	6.96
C=0.75	0.75	0.01	0.75	0.02	0.75	0.03	0.75	0.05
C=1.00	1.00	0.01	1.00	0.03	1.00	0.04	1.00	0.06
C=1.25	1.25	0.02	1.25	0.03	1.25	0.05	1.25	0.08

Table AII-3.—Stadia Reduction—Continued

Minutes	4°		5°		6°		7°	
	Hor. dist.	Diff. elev.	Hor. dist.	Diff. elev.	Hor. dist.	Diff. elev.	Hor. dist.	Diff. elev.
0	99.51	6.96	99.24	8.68	98.91	10.40	98.51	12.10
2	99.51	7.02	99.23	8.74	98.90	10.45	98.50	12.15
4	99.50	7.07	99.22	8.80	98.88	10.51	98.48	12.21
6	99.49	7.13	99.21	8.85	98.87	10.57	98.47	12.26
8	99.48	7.19	99.20	8.91	98.86	10.62	98.46	12.32
10	99.47	7.25	99.19	8.97	98.85	10.68	98.44	12.38
12	99.46	7.30	99.18	9.03	98.83	10.74	98.43	12.43
14	99.46	7.36	99.17	9.08	98.82	10.79	98.41	12.49
16	99.45	7.42	99.16	9.14	98.81	10.85	98.40	12.55
18	99.44	7.48	99.15	9.20	98.80	10.91	98.39	12.60
20	99.43	7.53	99.14	9.25	98.78	10.96	98.37	12.66
22	99.42	7.59	99.13	9.31	98.77	11.02	98.36	12.72
24	99.41	7.65	99.11	9.37	98.76	11.08	98.34	12.77
26	99.40	7.71	99.10	9.43	98.74	11.13	98.33	12.83
28	99.39	7.76	99.09	9.48	98.73	11.19	98.31	12.88
30	99.38	7.82	99.08	9.54	98.72	11.25	98.29	12.94
32	99.38	7.88	99.07	9.60	98.71	11.30	98.28	13.00
34	99.37	7.94	99.06	9.65	98.69	11.36	98.27	13.05
36	99.36	7.99	99.05	9.71	98.68	11.42	98.25	13.11
38	99.35	8.05	99.04	9.77	98.67	11.47	98.24	13.17
40	99.34	8.11	99.03	9.83	98.65	11.53	98.22	13.22
42	99.33	8.17	99.01	9.88	98.64	11.59	98.20	13.28
44	99.32	8.22	99.00	9.94	98.63	11.64	98.19	13.33
46	99.31	8.28	98.99	10.00	98.61	11.70	98.17	13.39
48	99.30	8.34	98.98	10.05	98.60	11.76	98.16	13.45
50	99.29	8.40	98.97	10.11	98.58	11.81	98.14	13.50
52	99.28	8.45	98.96	10.17	98.57	11.87	98.13	13.56
54	99.27	8.51	98.94	10.22	98.56	11.93	98.11	13.61
56	99.26	8.57	98.93	10.28	98.54	11.98	98.10	13.67
58	99.25	8.63	98.92	10.34	98.53	12.04	98.08	13.73
60	99.24	8.68	98.91	10.40	98.51	12.10	98.06	13.78
C=0.75	0.75	0.06	0.75	0.07	0.75	0.08	0.74	0.10
C=1.00	1.00	0.08	0.99	0.09	0.99	0.11	0.99	0.13
C=1.25	1.25	0.10	1.24	0.11	1.24	0.14	1.24	0.16

Table AII-3.—Stadia Reduction—Continued

Minutes	8°		9°		10°		11°	
	Hor. dist.	Diff. elev.	Hor. dist.	Diff. elev.	Hor. dist.	Diff. elev.	Hor. dist.	Diff. elev.
0	98.06	13.78	97.55	15.45	96.98	17.10	96.36	18.73
2	98.05	13.84	97.53	15.51	96.96	17.16	96.34	18.78
4	98.03	13.89	97.52	15.56	96.94	17.21	96.32	18.84
6	98.01	13.95	97.50	15.62	96.92	17.26	96.29	18.89
8	98.00	14.01	97.48	15.67	96.90	17.32	96.27	18.95
10	97.98	14.06	97.46	15.73	96.88	17.37	96.25	19.00
12	97.97	14.12	97.44	15.78	96.86	17.43	96.23	19.05
14	97.95	14.17	97.43	15.84	96.84	17.48	96.21	19.11
16	97.93	14.23	97.41	15.89	96.82	17.54	96.18	19.16
18	97.92	14.28	97.39	15.95	96.80	17.59	96.16	19.21
20	97.90	14.34	97.37	16.00	96.78	17.65	96.14	19.27
22	97.88	14.40	97.35	16.06	96.76	17.70	96.12	19.32
24	97.87	14.45	97.33	16.11	96.74	17.76	96.09	19.38
26	97.85	14.51	97.31	16.17	96.72	17.81	96.07	19.43
28	97.83	14.56	97.29	16.22	96.70	17.86	96.05	19.48
30	97.82	14.62	97.28	16.28	96.68	17.92	96.03	19.54
32	97.80	14.67	97.26	16.33	96.66	17.97	96.00	19.59
34	97.78	14.73	97.24	16.39	96.64	18.03	95.98	19.64
36	97.76	14.79	97.22	16.44	96.62	18.08	95.96	19.70
38	97.75	14.84	97.20	16.50	96.60	18.14	95.93	19.75
40	97.73	14.90	97.18	16.55	96.57	18.19	95.91	19.80
42	97.71	14.95	97.16	16.61	96.55	18.24	95.89	19.86
44	97.69	15.01	97.14	16.66	96.53	18.30	95.86	19.91
46	97.68	15.06	97.12	16.72	96.51	18.35	95.84	19.96
48	97.66	15.12	97.10	16.77	96.49	18.41	95.82	20.02
50	97.64	15.17	97.08	16.83	96.47	18.46	95.79	20.07
52	97.62	15.23	97.06	16.88	96.45	18.51	95.77	20.12
54	97.61	15.28	97.04	16.94	96.42	18.57	95.75	20.18
56	97.59	15.34	97.02	16.99	96.40	18.62	95.72	20.23
58	97.57	15.40	97.00	17.05	96.38	18.68	95.70	20.28
60	97.55	15.45	96.98	17.10	96.36	18.73	95.68	20.34
C=0.75	0.74	0.11	0.74	0.12	0.74	0.14	0.73	0.15
C=1.00	0.99	0.15	0.99	0.16	0.98	0.18	0.98	0.20
C=1.25	1.23	0.18	1.23	0.21	1.23	0.23	1.22	0.25

Table AII-3.—Stadia reduction—Continued

Minutes	12°		13°		14°		15°	
	Hor. dist.	Diff. elev.	Hor. dist.	Diff. elev.	Hor. dist.	Diff. elev.	Hor. dist.	Diff. elev.
0	95.68	20.34	94.94	21.92	94.15	23.47	93.30	25.00
2	95.65	20.39	94.91	21.97	94.12	23.52	93.27	25.05
4	95.63	20.44	94.89	22.02	94.09	23.58	93.24	25.10
6	95.61	20.50	94.86	22.08	94.07	23.63	93.21	25.15
8	95.58	20.55	94.84	22.13	94.04	23.68	93.18	25.20
10	95.56	20.60	94.81	22.18	94.01	23.73	93.16	25.25
12	95.53	20.66	94.79	22.23	93.98	23.78	93.13	25.30
14	95.51	20.71	94.76	22.28	93.95	23.83	93.10	25.35
16	95.49	20.76	94.73	22.34	93.93	23.88	93.07	25.40
18	95.46	20.81	94.71	22.39	93.90	23.93	93.04	25.45
20	95.44	20.87	94.68	22.44	93.87	23.99	93.01	25.50
22	95.41	20.92	94.66	22.49	93.84	24.04	92.98	25.55
24	95.39	20.97	94.63	22.54	93.81	24.09	92.95	25.60
26	95.36	21.03	94.60	22.60	93.79	24.14	92.92	25.65
28	95.34	21.08	94.58	22.65	93.76	24.19	92.89	25.70
30	95.32	21.13	94.55	22.70	93.73	24.24	92.86	25.75
32	95.29	21.18	94.52	22.75	93.70	24.29	92.83	25.80
34	95.27	21.24	94.50	22.80	93.67	24.34	92.80	25.85
36	95.24	21.29	94.47	22.85	93.65	24.39	92.77	25.90
38	95.22	21.34	94.44	22.91	93.62	24.44	92.74	25.95
40	95.19	21.39	94.42	22.96	93.59	24.49	92.71	26.00
42	95.17	21.45	94.39	23.01	93.56	24.55	92.68	26.05
44	95.14	21.50	94.36	23.06	93.53	24.60	92.65	26.10
46	95.12	21.55	94.34	23.11	93.50	24.65	92.62	26.15
48	95.09	21.60	94.31	23.16	93.47	24.70	92.59	26.20
50	95.07	21.66	94.28	23.22	93.45	24.75	92.56	26.25
52	95.04	21.71	94.26	23.27	93.42	24.80	92.53	26.30
54	95.02	21.76	94.23	23.32	93.39	24.85	92.49	26.35
56	94.99	21.81	94.20	23.37	93.36	24.90	92.46	26.40
58	94.97	21.87	94.17	23.42	93.33	24.95	92.43	26.45
60	94.94	21.92	94.15	23.47	93.90	25.00	92.40	26.50
C=0.75	0.73	0.16	0.73	0.17	0.73	0.19	0.72	0.20
C=1.00	0.98	0.22	0.97	0.23	0.97	0.25	0.96	0.27
C=1.25	1.22	0.27	1.21	0.29	1.21	0.31	1.20	0.34

Table AII-3.—Stadia Reduction—Continued

Minutes	16°		17°		18°		19°	
	Hor. dist.	Diff. elev.	Hor. dist.	Diff. elev.	Hor. dist.	Diff. elev.	Hor. dist.	Diff. elev.
0	92.40	26.50	91.45	27.96	90.45	29.39	89.40	30.78
2	92.37	26.55	91.42	28.01	90.42	29.44	89.36	30.83
4	92.34	26.59	91.39	28.06	90.38	29.48	89.33	30.87
6	92.31	26.64	91.35	28.10	90.35	29.53	89.29	30.92
8	92.28	26.69	91.32	28.15	90.31	29.58	89.26	30.97
10	92.25	26.74	91.29	28.20	90.28	29.62	89.22	31.01
12	92.22	26.79	91.26	28.25	90.24	29.67	89.18	31.06
14	92.19	26.84	91.22	28.30	90.21	29.72	89.15	31.10
16	92.15	26.89	91.19	28.34	90.18	29.76	89.11	31.15
18	92.12	26.94	91.16	28.39	90.14	29.81	89.08	31.19
20	92.09	26.99	91.12	28.44	90.11	29.86	89.04	31.24
22	92.06	27.04	91.09	28.49	90.07	29.90	89.00	31.28
24	92.03	27.09	91.06	28.54	90.04	29.95	88.96	31.33
26	92.00	27.13	91.02	28.58	90.00	30.00	88.93	31.38
28	91.97	27.18	90.99	28.63	89.97	30.04	88.89	31.42
30	91.93	27.23	90.96	28.68	89.93	30.09	88.86	31.47
32	91.90	27.28	90.92	28.73	89.90	30.14	88.82	31.51
34	91.87	27.33	90.89	28.77	89.86	30.19	88.78	31.56
36	91.84	27.38	90.86	28.82	89.83	30.23	88.75	31.60
38	91.81	27.43	90.82	28.87	89.79	30.28	88.71	31.65
40	91.77	27.48	90.79	28.92	89.76	30.32	88.67	31.69
42	91.74	27.52	90.76	28.96	89.72	30.37	88.64	31.74
44	91.71	27.57	90.72	29.01	89.69	30.41	88.60	31.78
46	91.68	27.62	90.69	29.06	89.65	30.46	88.56	31.83
48	91.65	27.67	90.66	29.11	89.61	30.51	88.53	31.87
50	91.61	27.72	90.62	29.15	89.58	30.55	88.49	31.92
52	91.58	27.77	90.59	29.20	89.54	30.60	88.45	31.96
54	91.55	27.81	90.55	29.25	89.51	30.65	88.41	32.01
56	91.52	27.86	90.52	29.30	89.47	30.69	88.38	32.05
58	91.48	27.91	90.48	29.34	89.44	30.74	88.34	32.09
60	91.45	27.96	90.45	29.39	89.40	30.78	88.30	32.14
C=0.75	0.72	0.21	0.72	0.23	0.71	0.24	0.71	0.25
C=1.00	0.96	0.28	0.95	0.30	0.95	0.32	0.94	0.33
C=1.25	1.20	0.35	1.19	0.38	1.19	0.40	1.18	0.42

Table AII-3.—Stadia Reduction—Continued

Minutes	20°		21°		22°		23°	
	Hor. dist.	Diff. elev.	Hor. dist.	Diff. elev.	Hor. dist.	Diff. elev.	Hor. dist.	Diff. elev.
0	88.30	32.14	87.16	33.46	85.97	34.73	84.73	35.97
2	88.26	32.18	87.12	33.50	85.93	34.77	84.69	36.01
4	88.23	32.23	87.08	33.54	85.89	34.82	84.65	36.05
6	88.19	32.27	87.04	33.59	85.85	34.86	84.61	36.09
8	88.15	32.32	87.00	33.63	85.80	34.90	84.57	36.13
10	88.11	32.36	86.96	33.67	85.76	34.94	84.52	36.17
12	88.08	32.41	86.92	33.72	85.72	34.98	84.48	36.21
14	88.04	32.45	86.88	33.76	85.68	35.02	84.44	36.25
16	88.00	32.49	86.84	33.80	85.64	35.07	84.40	36.29
18	87.96	32.54	86.80	33.84	85.60	35.11	84.35	36.33
20	87.93	32.58	86.77	33.89	85.56	35.15	84.31	36.37
22	87.89	32.63	86.73	33.93	85.52	35.19	84.27	36.41
24	87.85	32.67	86.69	33.97	85.48	35.23	84.23	36.45
26	87.81	32.72	86.65	34.01	85.44	35.27	84.18	36.49
28	87.77	32.76	86.61	34.06	85.40	35.31	84.14	36.53
30	87.74	32.80	86.57	34.10	85.36	35.36	84.10	36.57
32	87.70	32.85	86.53	34.14	85.31	35.40	84.06	36.61
34	87.66	32.89	86.49	34.18	85.27	35.44	84.01	36.65
36	87.62	32.93	86.45	34.23	85.23	35.48	83.97	36.69
38	87.58	32.98	86.41	34.27	85.19	35.52	83.93	36.73
40	87.54	33.02	86.37	34.31	85.15	35.56	83.89	36.77
42	87.51	33.07	86.33	34.35	85.11	35.60	83.84	36.80
44	87.47	33.11	86.29	34.40	85.07	35.64	83.80	36.84
46	87.43	33.15	86.25	34.44	85.02	35.68	83.76	36.88
48	87.39	33.20	86.21	34.48	84.98	35.72	83.72	36.92
50	87.35	33.24	86.17	34.52	84.94	35.76	83.67	36.96
52	87.31	33.28	86.13	34.57	84.90	35.80	83.63	37.00
54	87.27	33.33	86.09	34.61	84.86	35.85	83.59	37.04
56	87.24	33.37	86.05	34.65	84.82	35.89	83.54	37.08
58	87.20	33.41	86.01	34.69	84.77	35.93	83.50	37.12
60	87.16	33.46	85.97	34.73	84.73	35.97	83.46	37.16
C=0.75	0.70	0.26	0.70	0.27	0.69	0.29	0.69	0.30
C=1.00	0.94	0.35	0.93	0.37	0.92	0.38	0.92	0.40
C=1.25	1.17	0.44	1.16	0.46	1.15	0.48	1.15	0.50

Table AII-3.—Stadia Reduction—Continued

Minutes	24°		25°		26°		27°	
	Hor. dist.	Diff. elev.	Hor. dist.	Diff. elev.	Hor. dist.	Diff. elev.	Hor. dist.	Diff. elev.
0	83.46	37.16	82.14	38.30	80.78	39.40	79.39	40.45
2	83.41	37.20	82.09	38.34	80.74	39.44	79.34	40.49
4	83.37	37.23	82.05	38.38	80.69	39.47	79.30	40.52
6	83.33	37.27	82.01	38.41	80.65	39.51	79.25	40.55
8	83.28	37.31	81.96	38.45	80.60	39.54	79.20	40.59
10	83.24	37.35	81.92	38.49	80.55	39.58	79.15	40.62
12	83.20	37.39	81.87	38.53	80.51	39.61	79.11	40.66
14	83.15	37.43	81.83	38.56	80.46	39.65	79.06	40.69
16	83.11	37.47	81.78	38.60	80.41	39.69	79.01	40.72
18	83.07	37.51	81.74	38.64	80.37	39.72	78.96	40.76
20	83.02	37.54	81.69	38.67	80.32	39.76	78.92	40.79
22	82.98	37.58	81.65	38.71	80.28	39.79	78.87	40.82
24	82.93	37.62	81.60	38.75	80.23	39.83	78.82	40.86
26	82.89	37.66	81.56	38.78	80.18	39.86	78.77	40.89
28	82.85	37.70	81.51	38.82	80.14	39.90	78.73	40.92
30	82.80	37.74	81.47	38.86	80.09	39.93	78.68	40.96
32	82.76	37.77	81.42	38.89	80.04	39.97	78.63	40.99
34	82.72	37.81	81.38	38.93	80.00	40.00	78.58	41.02
36	82.67	37.85	81.33	38.97	79.95	40.04	78.54	41.06
38	82.63	37.89	81.28	39.00	79.90	40.07	78.49	41.09
40	82.58	37.93	81.24	39.04	79.86	40.11	78.44	41.12
42	82.54	37.96	81.19	39.08	79.81	40.14	78.39	41.16
44	82.49	38.00	81.15	39.11	79.76	40.18	78.34	41.19
46	82.45	38.04	81.10	39.15	79.72	40.21	78.30	41.22
48	82.41	38.08	81.06	39.18	79.67	40.24	78.25	41.26
50	82.36	38.11	81.01	39.22	79.62	40.28	78.20	41.29
52	82.32	38.15	80.97	39.26	79.58	40.31	78.15	41.32
54	82.27	38.19	80.92	39.29	79.53	40.35	78.10	41.35
56	82.23	38.23	80.87	39.33	79.48	40.38	78.06	41.39
58	82.18	38.26	80.83	39.36	79.44	40.42	78.01	41.42
60	82.14	38.30	80.78	39.40	79.39	40.45	77.96	41.45
C=0.75	0.68	0.31	0.68	0.32	0.67	0.33	0.66	0.35
C=1.00	0.91	0.41	0.90	0.43	0.89	0.45	0.89	0.46
C=1.25	1.14	0.52	1.13	0.54	1.12	0.56	1.11	0.58

Table AII-3.—Stadia Reduction—Continued

Minutes	28°		29°		30°	
	Hor. dist.	Diff. elev.	Hor. dist.	Diff. elev.	Hor. dist.	Diff. elev.
0	77.96	41.45	76.50	42.40	75.00	43.30
2	77.91	41.48	76.45	42.43	74.95	43.33
4	77.86	41.52	76.40	42.46	74.90	43.36
6	77.81	41.55	76.35	42.49	74.85	43.39
8	77.77	41.58	76.30	42.53	74.80	43.42
10	77.72	41.61	76.25	42.56	74.75	43.45
12	77.67	41.65	76.20	42.59	74.70	43.47
14	77.62	41.68	76.15	42.62	74.65	43.50
16	77.57	41.71	76.10	42.65	74.60	43.53
18	77.52	41.74	76.05	42.68	74.55	43.56
20	77.48	41.77	76.00	42.71	74.49	43.59
22	77.42	41.81	75.95	42.74	74.44	43.62
24	77.38	41.84	75.90	42.77	74.39	43.65
26	77.33	41.87	75.85	42.80	74.34	43.67
28	77.28	41.90	75.80	42.83	74.29	43.70
30	77.23	41.93	75.75	42.86	74.24	43.73
32	77.18	41.97	75.70	42.89	74.19	43.76
34	77.13	42.00	75.65	42.92	74.14	43.79
36	77.09	42.03	75.60	42.95	74.09	43.82
38	77.04	42.06	75.55	42.98	74.04	43.84
40	76.99	42.09	75.50	43.01	73.99	43.87
42	76.94	42.12	75.45	43.04	73.93	43.90
44	76.89	42.15	75.40	43.07	73.88	43.93
46	76.84	42.19	75.35	43.10	73.83	43.95
48	76.79	42.22	75.30	43.13	73.78	43.98
50	76.74	42.25	75.25	43.16	73.73	44.01
52	76.69	42.28	75.20	43.18	73.68	44.04
54	76.64	42.31	75.15	43.21	73.63	44.07
56	76.59	42.34	75.10	43.24	73.58	44.09
58	76.55	42.37	75.05	43.27	73.52	44.12
60	76.50	42.40	75.00	43.30	73.47	44.15
C=0.75	0.66	0.36	0.65	0.37	0.65	0.38
C=1.00	0.88	0.48	0.87	0.49	0.86	0.51
C=1.25	1.10	0.60	1.09	0.62	1.08	0.64

APPENDIX III

SAMPLE SURVEY FIELD NOTES

The field notes contained in this Appendix are presented to show you, the EA2 survey party chief or the EA1 supervisor, how a series of notes are indexed and arranged in a field notebook For completeness, the field notes shown in appendix V of the EA3 TRAMAN are repeated in this Appendix.

The field notes in this Appendix are samples of the types of notes that are kept in surveying. They are not intended to describe how the notes should be kept. That is up to you. You are the one who decides what minimum information is necessary to achieve complete notes, and you are the one who decides how that information is to be recorded. As you are well aware, note keeping is not only an art that makes your notes clean and legible but it is also a science that makes your notes meaningful and correct.

Figures AIII-1 and AIII-2 are samples of the front page and index of a notebook. The front page should be filled out as required by your unit. A separate book should, when possible, be kept for each major project. The index should show all surveying projects by page number and must be kept up-to-date at all times.

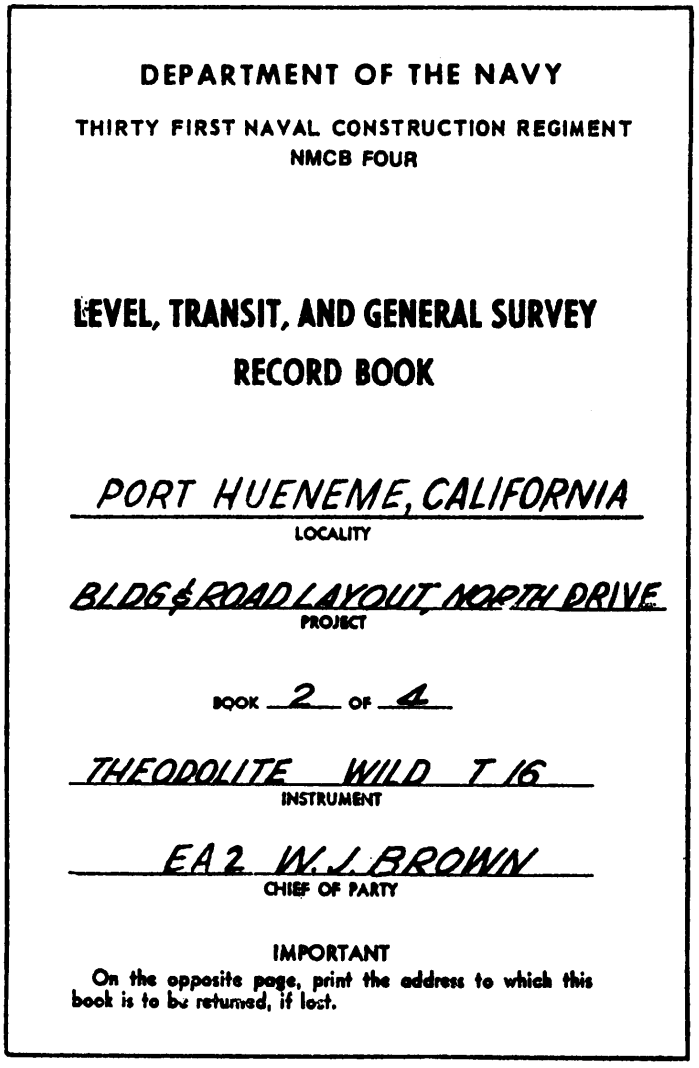
An example of recording horizontal measurements is shown in figure AIII-3. To record taping problems, record distance measured (by parts of tapes, if measured) going from one station to the next. Record in the direction in which measured; that is, down for forward measurements, up for backward measurements.

A page check of a direct-level circuit is shown in figure AIII-4. As you recall, when page checking you are determining that the difference between the sum of the backlights and the sum of the forsights is equal to the difference in elevation between the initial benchmark or turning point and the final benchmark or turning point. For direct-level notes exceeding one page, the page check should always be made for each separate page of the notes. The final page should, in addition, show also a check from start to finish of the entire circuit. Remember, too, that when making a page check, you are checking only the accuracy of the arithmetic, not the accuracy of the level shots.

Figure AIII-5 shows horizon closure for a traverse station. In this example, each angle was repeated twice, once direct and once reverse, using the procedures you studied in chapter 13 of the EA3 TRAMAN for measuring angles by repetition.

Turn all angles, direct and reverse, to the right. Enter means, and if mean does not match single reading to ±30", reshoot the angles. Never proceed to the next station until horizon closure (360° ±30") has been achieved.

Figures AIII-6 and AIII-7 show, respectively, notes for a station-angle traverse and a deflection-angle traverse.



DEPARTMENT OF THE NAVY

THIRTY FIRST NAVAL CONSTRUCTION REGIMENT
NMCB FOUR

LEVEL, TRANSIT, AND GENERAL SURVEY
RECORD BOOK

PORT HUENEME, CALIFORNIA
LOCALITY

BLDG & ROAD LAYOUT, NORTH DRIVE
PROJECT

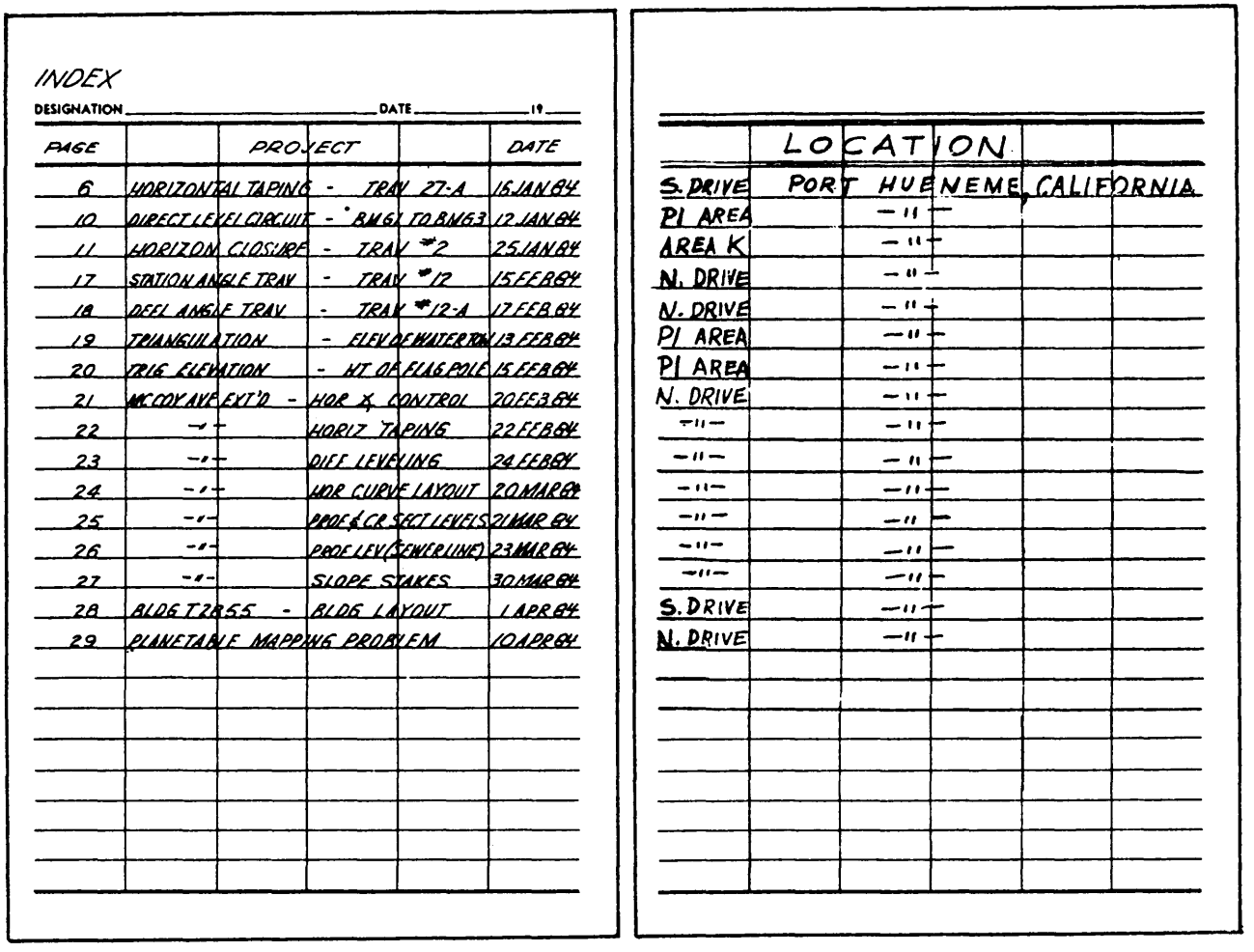
BOOK 2 OF 4

THEODOLITE WILD T 16
INSTRUMENT

EA2 W.J. BROWN
CHIEF OF PARTY

IMPORTANT
On the opposite page, print the address to which this book is to be returned, if lost.

Figure AIII-1.—Front page of a notebook.



INDEX

DESIGNATION _____ DATE _____ 19____

PAGE		PROJECT			DATE
6	HORIZONTAL TAPING	-	TRAV 27-A		16 JAN 84
10	DIRECT LEVEL CIRCUIT	-	BMG1 TO BMG3		12 JAN 84
11	HORIZON CLOSURE	-	TRAV #2		25 JAN 84
17	STATION ANGLE TRAV	-	TRAV #12		15 FEB 84
18	DEFL ANGLE TRAV	-	TRAV #12-A		17 FEB 84
19	TRIANGULATION	-	ELEV DETERMIN		13 FEB 84
20	TRIG ELEVATION	-	HT OF FLAG POLE		15 FEB 84
21	MCCOY AVE EXT'D	-	HOR & CONTROL		20 FEB 84
22	-"-		HORIZ TAPING		22 FEB 84
23	-"-		DIFF LEVELING		24 FEB 84
24	-"-		HOR CURVE LAYOUT		20 MAR 84
25	-"-		PROF & CR SECT LEVELS		21 MAR 84
26	-"-		PROF LEV (SEWER LINE)		23 MAR 84
27	-"-		SLOPE STAKES		30 MAR 84
28	BLDG T2855	-	BLDG LAYOUT		1 APR 84
29	PLANETABLE MAPPING PROBLEM				10 APR 84

	LOCATION				
S. DRIVE	PORT HUENEME, CALIFORNIA				
PI AREA	—"—				
AREA K	—"—				
N. DRIVE	—"—				
N. DRIVE	—"—				
PI AREA	—"—				
PI AREA	—"—				
N. DRIVE	—"—				
—"—	—"—				
—"—	—"—				
—"—	—"—				
—"—	—"—				
—"—	—"—				
—"—	—"—				
S. DRIVE	—"—				
N. DRIVE	—"—				

Figure AIII-2.—Index.

The set of horizontal angle control notes shown in figure AIII-8 indicates that the instrument was first set up over station 0 + 00 and indexed on point No. 1. The horizontal angle (to the right) to PI No. 1 was then turned, as well as the horizontal angle to a church steeple. This locates the traverse and ties it to a point that will not be disturbed The instrument was then moved to PI No. 1 and the deflection angle between 0 + 00 and PI No. 2 was turned (twice), making sure that the angle was recorded with its proper direction: right (R). The instrument was then moved to PI No. 2 and the procedures repeated

'The set of horizontal taping notes in figure AIII-9 shows the proper way to tape and record distances between points. The line in question is taped in both directions, showing each distance and the mean distance. The mean distance must be within 1 in 5,000, or third-order accuracy. A good complete sketch is required.

Differential leveling notes are shown in figure AIII-10. When making the page check do not add the foresight for station 0 + 00, as it is a side shot. Also, note that the stadia distance to 0 + 00 has been omitted for the same reason. When making your sketch, you do not need to show the backsight and foresight distances on the sketch-only on the traverse points, and so forth, normally found on a sketch.

Horizontal curve notes (fig. AIII-11) should include all the curve data plus the deflection angles that are to be turned during the layout of the curve. The sketch should be as shown here. All stations that were staked out should be shown and labeled on the sketch.

Profile and cross-section level notes (fig. AIII-12) are best recorded from the bottom to the top of the page. The left-hand side of the notes should contain columns for stations, backsight (+), height of instrument (HI), foresight (-), and elevations. The right side, as shown, has left, center-line, and right columns. The top number

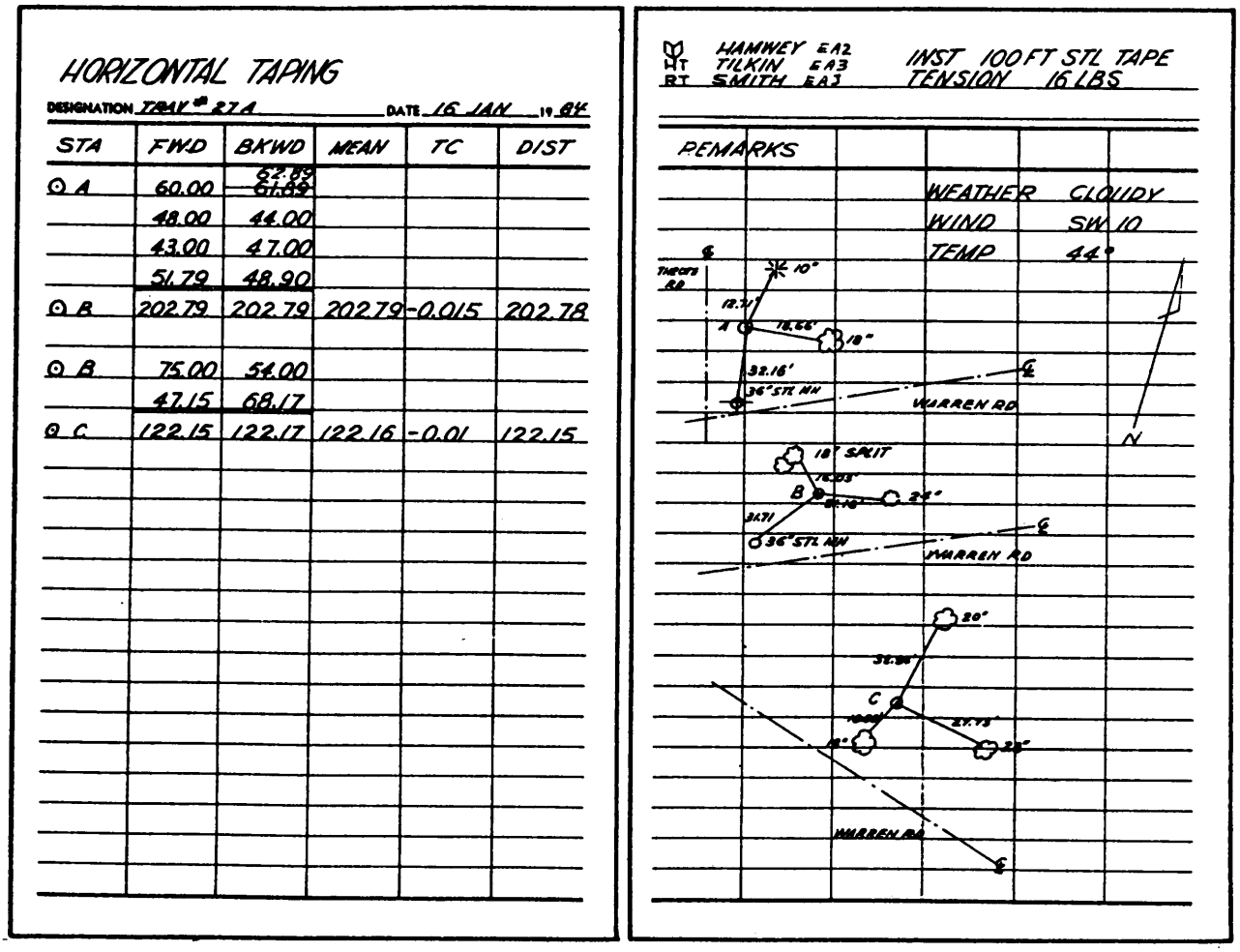


Figure AIII-3.—Horizontal taping.

is the ground elevation at that point, the center number is the rod reading, and the bottom number is the perpendicular distance to the centerline. An additional example of profile levels is shown in figure AIII-13.

Slope-stake notes (fig. AIII-14), as with profile notes, are best recorded from the bottom to the top of the page. As you see in the figure, in addition to grade rod, the right-hand page of the notes has left, center-line, and right columns. In these columns the amount of cut or fill, ground rod, and the distance of the slope stakes from the center line are recorded for each station.

Notes for a building layout are shown in figure AIII-15. Building corner numbers on the sketch must agree with the designation on the left-hand side of the notes. Grade rod setting is computed in the field. Batter elevations are entered in the first column on the right-hand side of the notes—after having been computed at the jobsite. The sketch must show all pertinent data for locating the building.

Typical notes for a plane-table survey are shown in figure AIII-16.

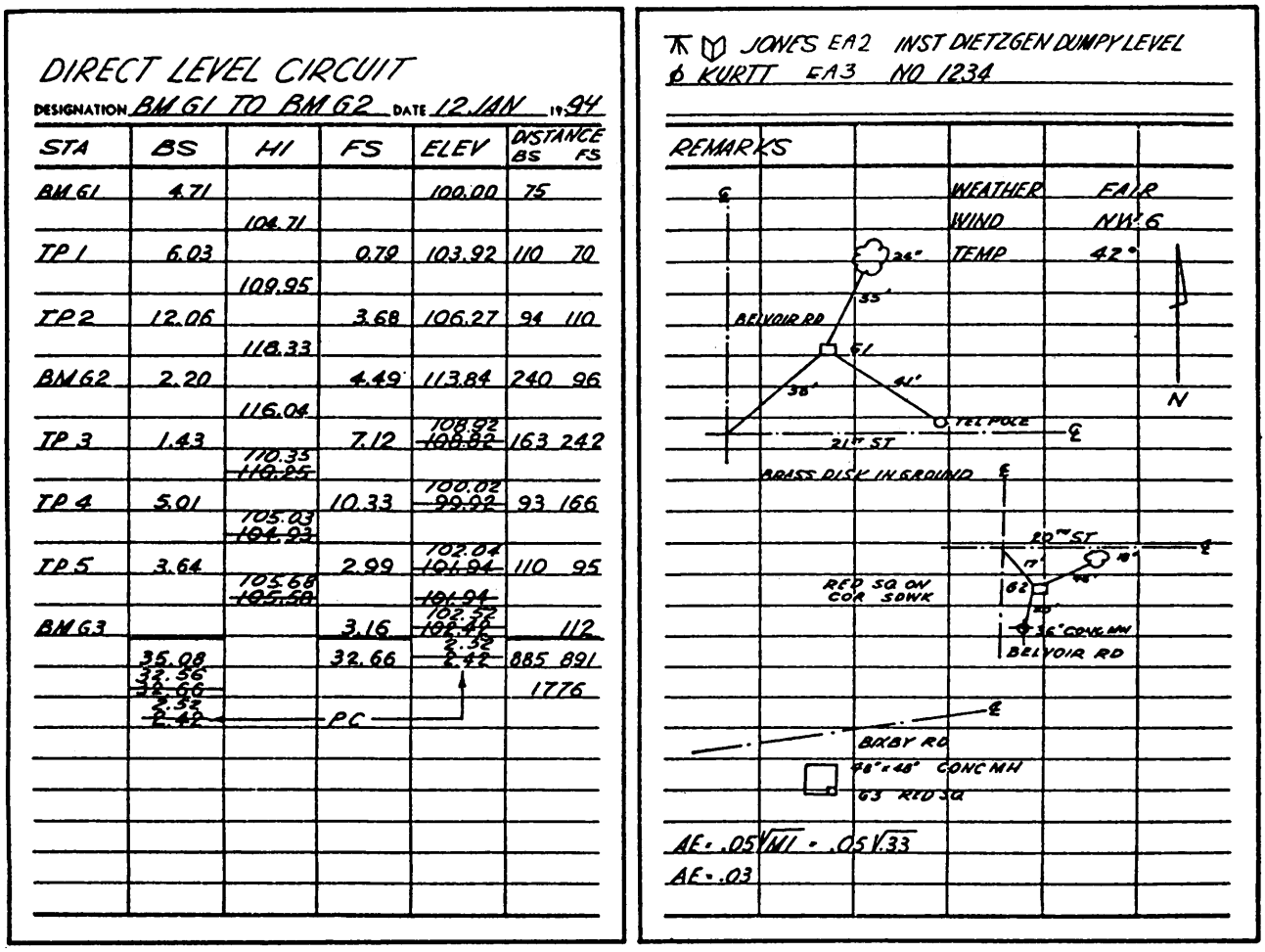


Figure AIII-4.—Page check.

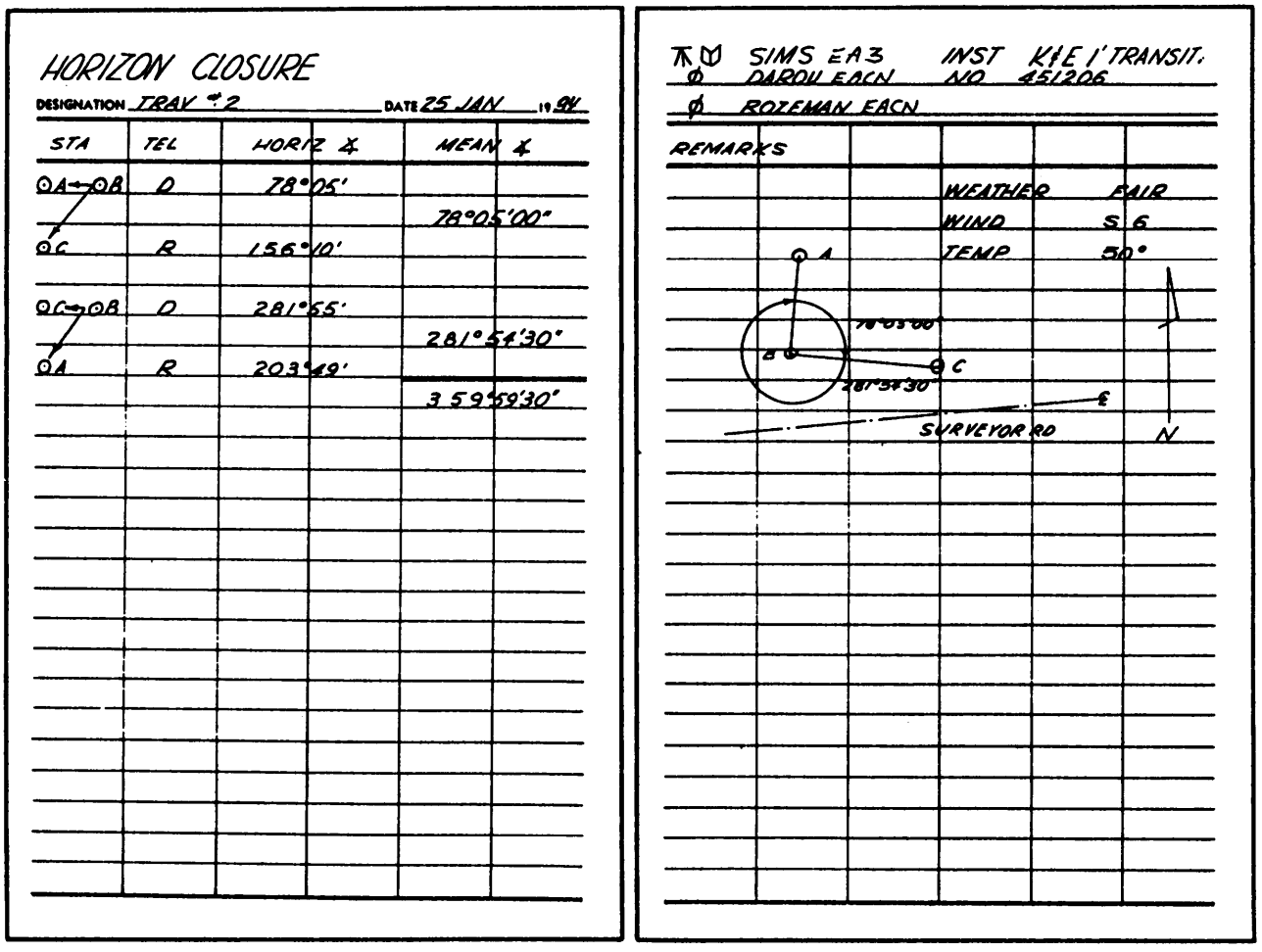


Figure AIII-5.—Horizon closure.

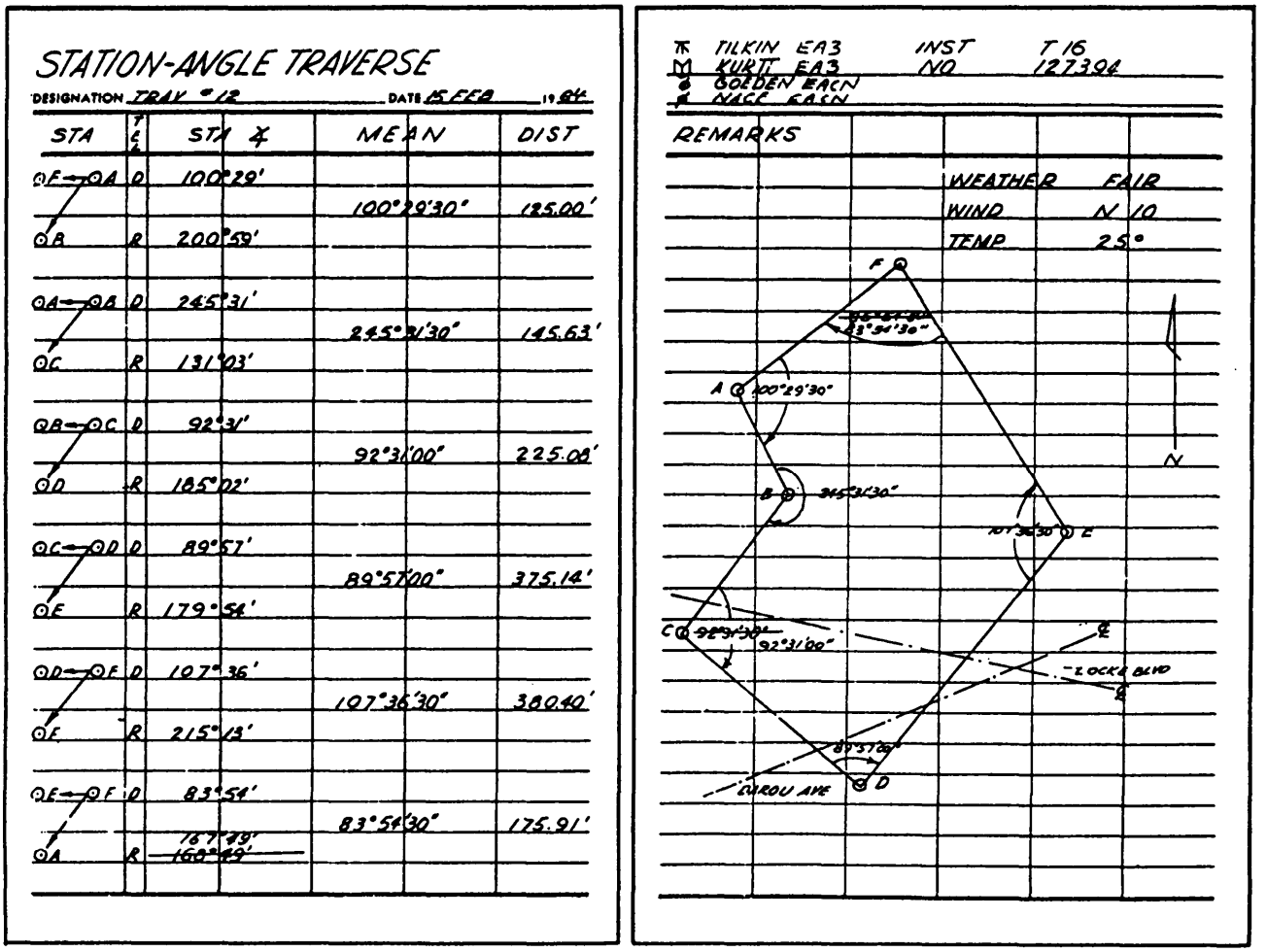
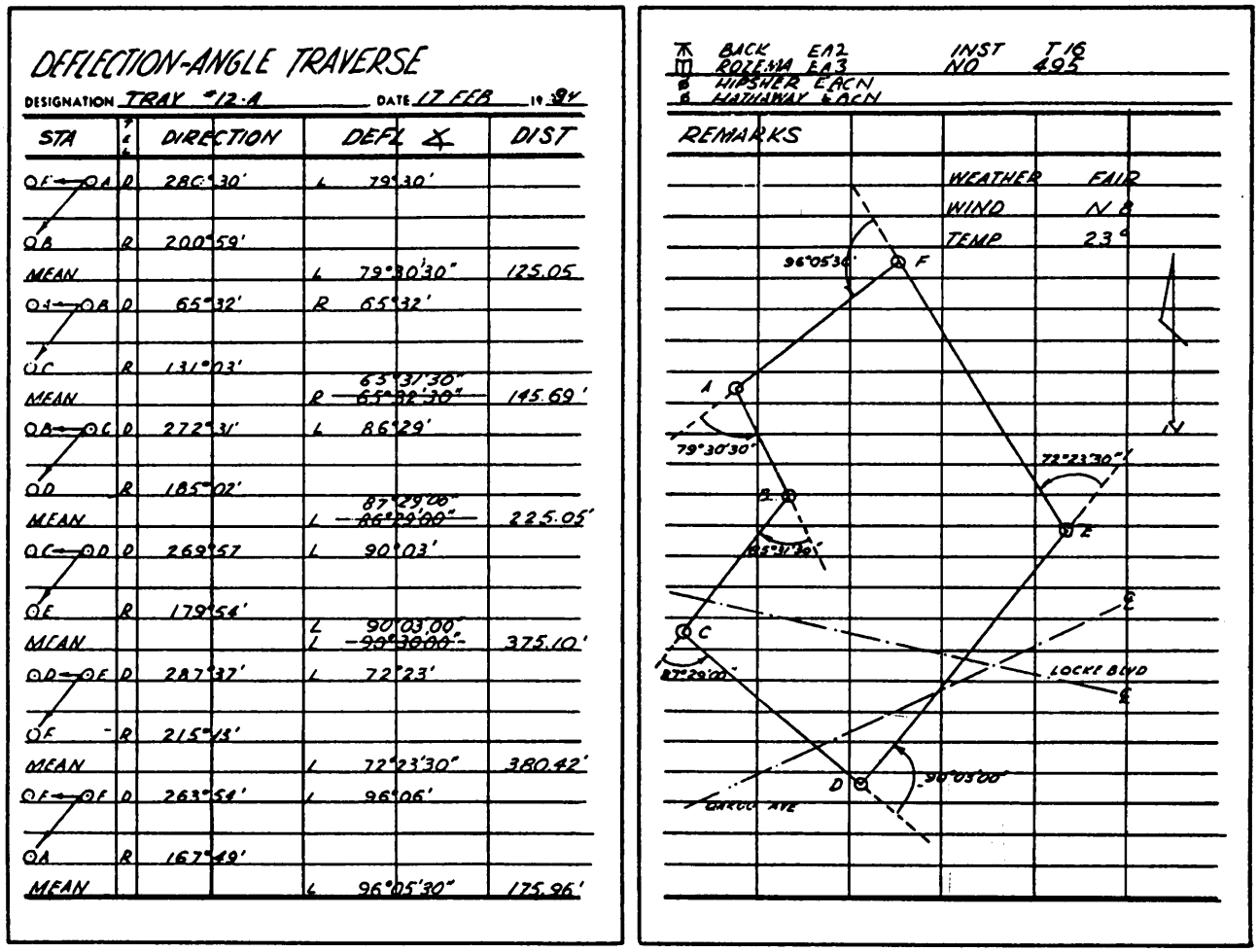


Figure AIII-6.—Station-angle traverse.



DEFLECTION-ANGLE TRAVERSE

DESIGNATION TRAV #12-A DATE 17 FEB 19 84

STA	L or R	DIRECTION	DEFL ∠	DIST
OF—OA	R	280°30'	L 79°30'	
OA	R	200°59'		
MEAN			L 79°30'30"	125.05
OA—OB	R	65°32'	R 65°32'	
OB	R	131°03'		
MEAN			R ~~65°32'30"~~ 63°37'30"	145.69'
OA—OC	R	272°31'	L 86°29'	
OC	R	185°02'		
MEAN			L ~~86°29'00"~~ 87°29'00"	225.05'
OC—OD	R	269°57	L 90°03'	
OE	R	179°54'		
MEAN			L ~~90°03'00"~~ 90°03'00"	375.10'
OD—OE	R	287°37'	L 72°23'	
OF	R	215°13'		
MEAN			L 72°23'30"	380.42'
OE—OF	R	263°54'	L 96°06'	
OA	R	167°49'		
MEAN			L 96°05'30"	175.96'

Figure AIII-7.—Deflection-angle traverse.

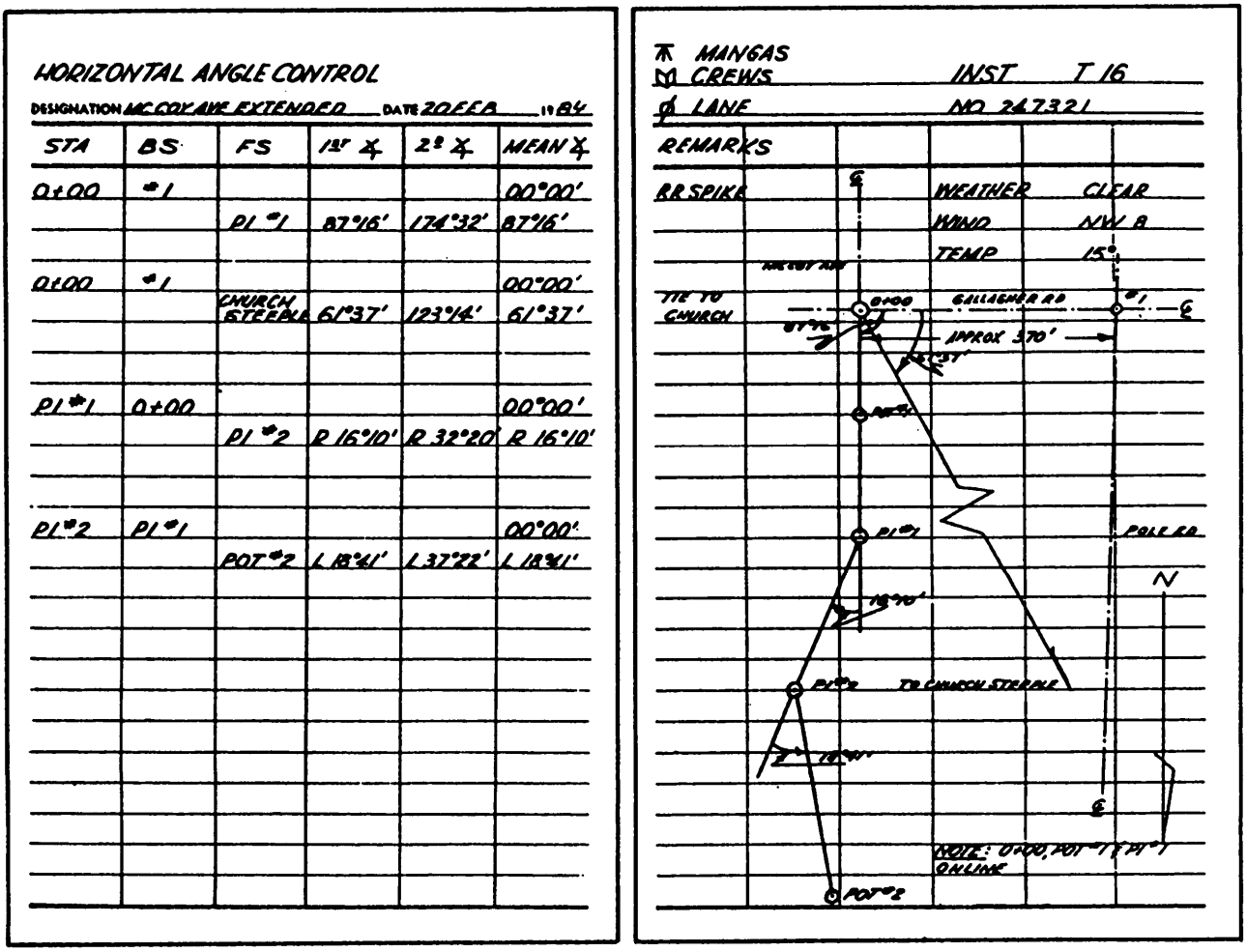
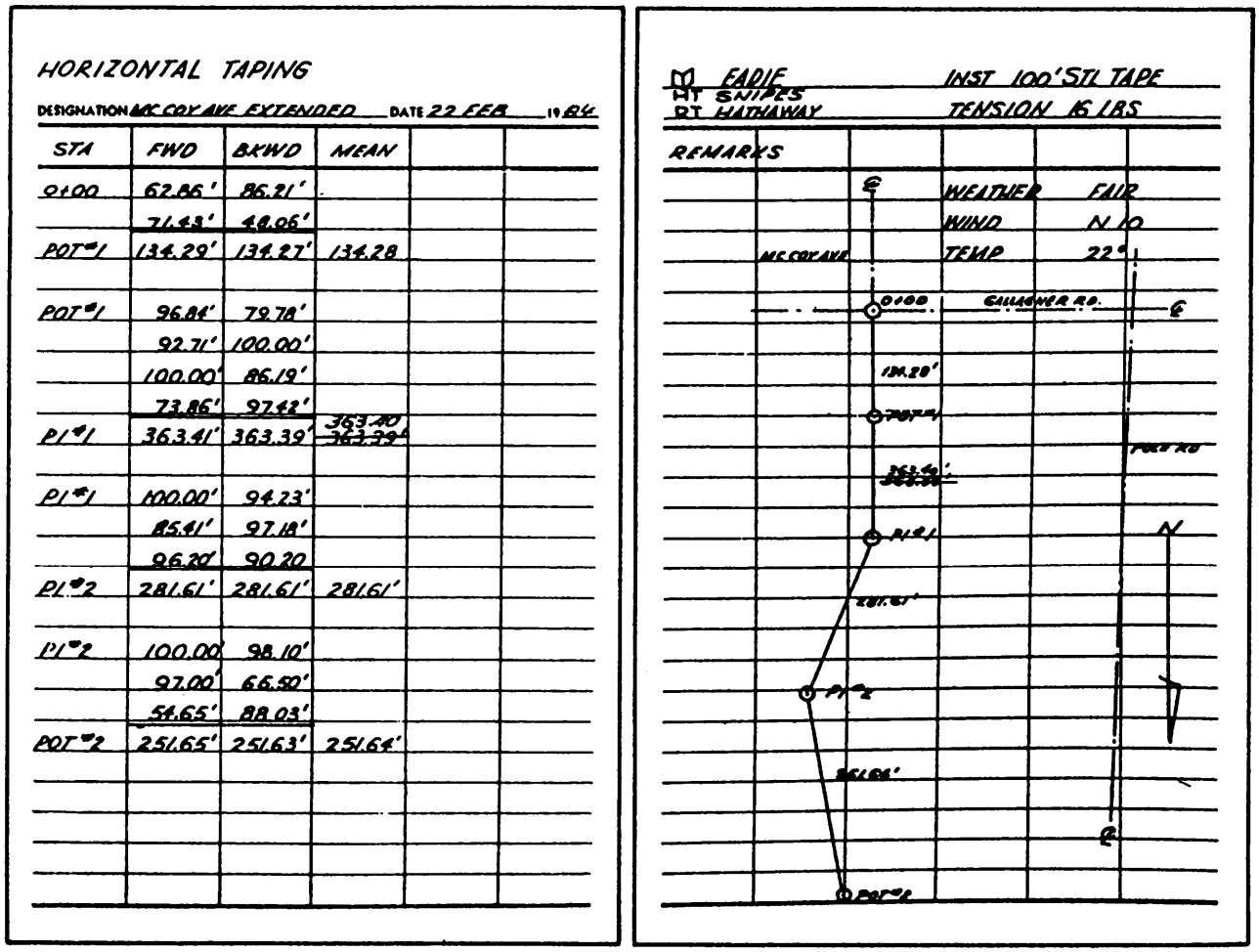


Figure AIII-8.—Horizontal angle control.



HORIZONTAL TAPING

DESIGNATION MC COY AVE EXTENDED DATE 22 FEB 19 84

STA	FWD	BKWD	MEAN
0+00	62.86'	86.21'	
	71.43'	48.06'	
POT #1	134.29'	134.27'	134.28
POT #1	96.84'	79.78'	
	92.71'	100.00'	
	100.00'	86.19'	
	73.86'	97.42'	
P/I #1	363.41'	363.39'	363.40 363.39
P/I #1	100.00'	94.23'	
	85.41'	97.18'	
	96.20'	90.20	
P/I #2	281.61'	281.61'	281.61'
P/I #2	100.00'	98.10'	
	97.00'	66.50'	
	54.65'	88.03'	
POT #2	251.65'	251.63'	251.64'

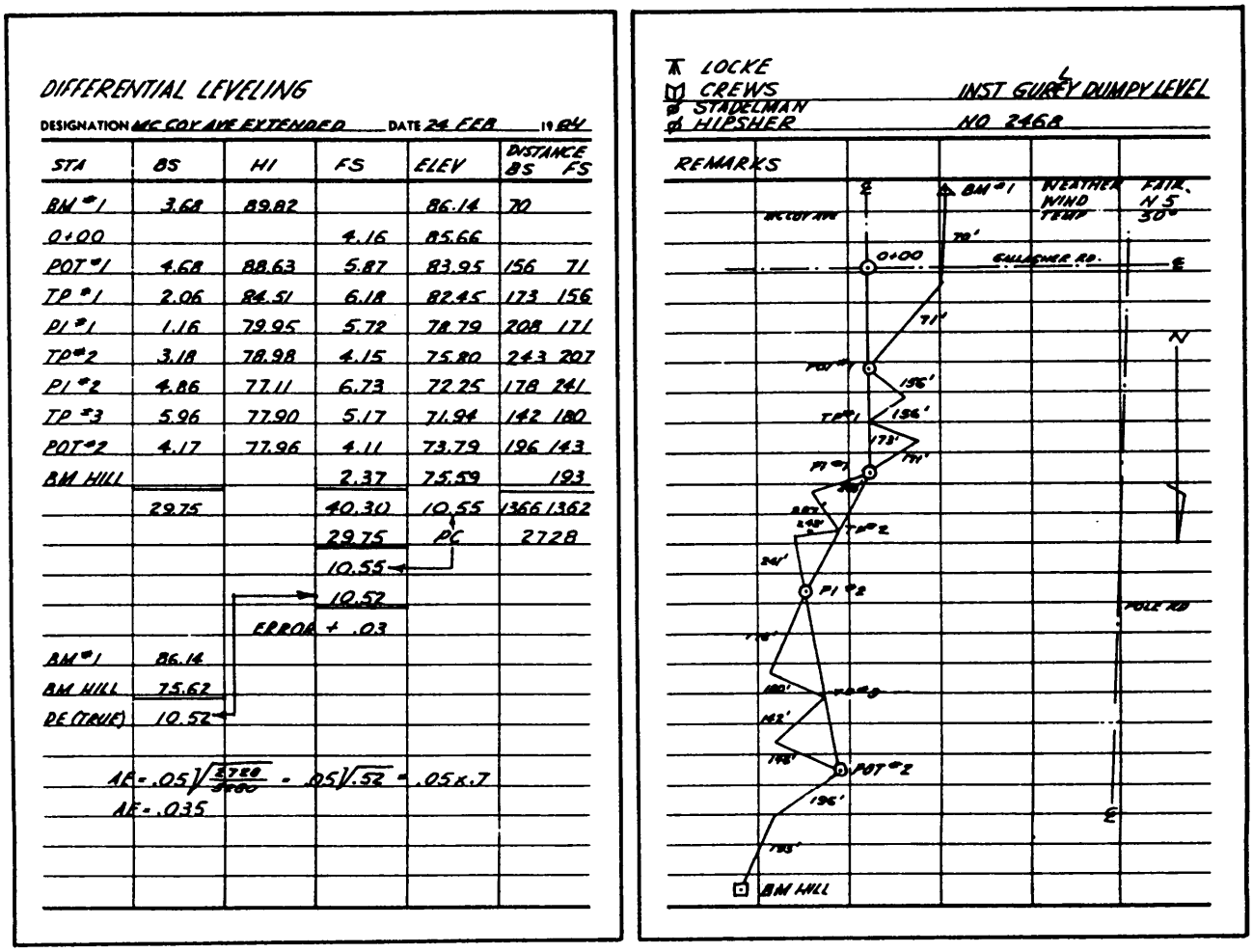
FADIE INST 100' STL TAPE
HT SNIPES
RT HATHAWAY TENSION 15 LBS

REMARKS

WEATHER FAIR
WIND N 10
TEMP 22°

MC COY AVE
0+00
GALLAGHER RD.
134.28'
FOLEY RD
N
281.61'
251.64'

Figure AIII-9.—Horizontal taping between stations.



DIFFERENTIAL LEVELING

DESIGNATION MC COY AVE EXTENDED DATE 24 FEB 19 84

STA	BS	HI	FS	ELEV	DISTANCE BS	DISTANCE FS
BM #1	3.68	89.82		86.14	70	
0+00			4.16	85.66		
POT #1	4.68	88.63	5.87	83.95	156	71
TP #1	2.06	84.51	6.18	82.45	173	156
PI #1	1.16	79.95	5.72	78.79	208	171
TP #2	3.18	78.98	4.15	75.80	243	207
PI #2	4.86	77.11	6.73	72.25	178	241
TP #3	5.96	77.90	5.17	71.94	142	180
POT #2	4.17	77.96	4.11	73.79	196	143
BM HILL			2.37	75.59		193
	29.75		40.30	10.55	1366	1362
			29.75	PC		2728
			10.55			
			10.52			
		ERROR	+ .03			
BM #1	86.14					
BM HILL	75.62					
DE (TRUE)	10.52					

$AE = .05\sqrt{\frac{2728}{3600}} = .05\sqrt{.52} = .05 \times .7$

$AE = .035$

LOCKE
CREWS
STADELMAN
HIPSHER

INST GURLEY DUMPY LEVEL NO 246R

REMARKS

WEATHER FAIR
WIND N 5
TEMP 30°

Figure AIII-10.—Differential leveling.

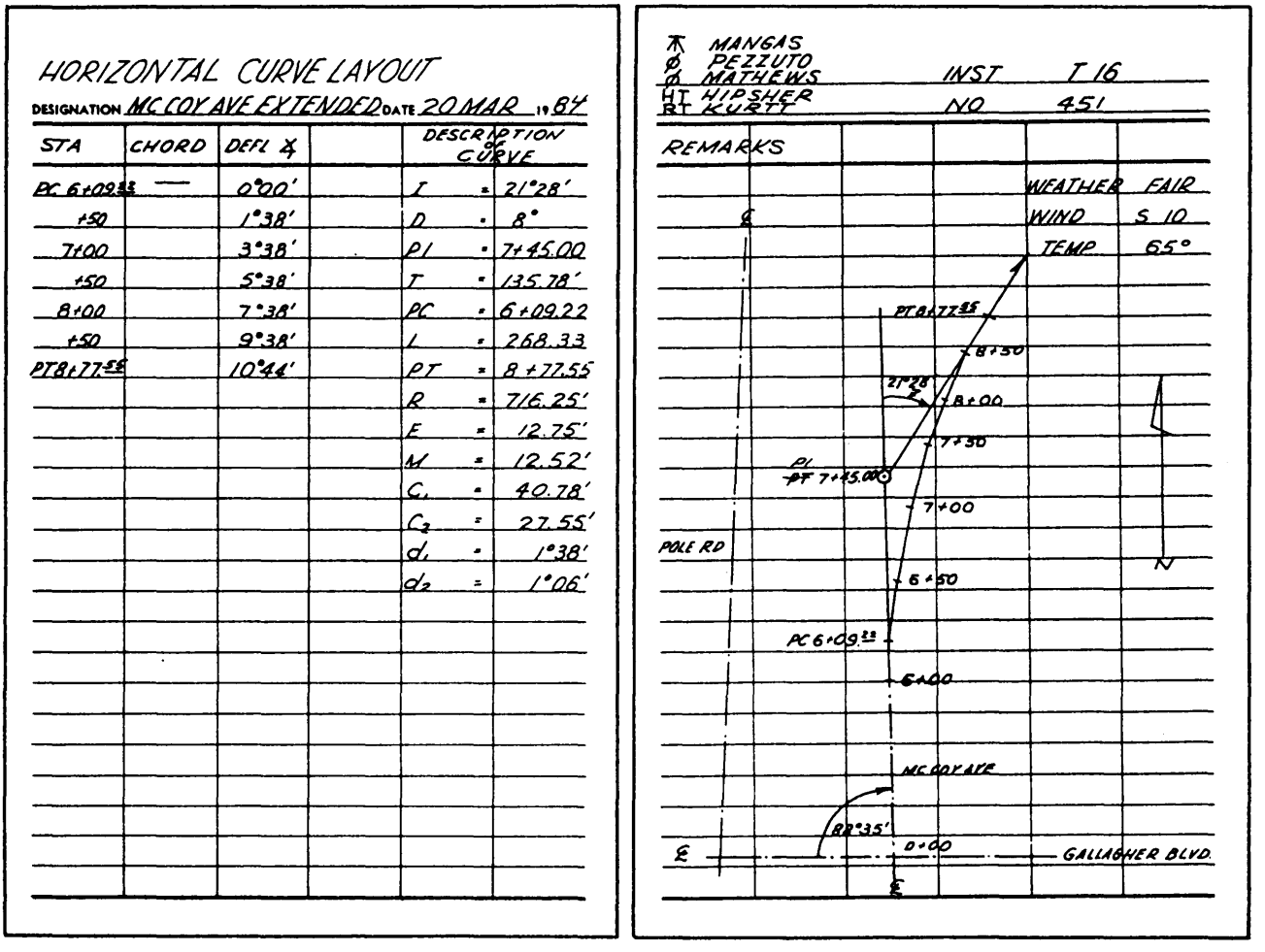
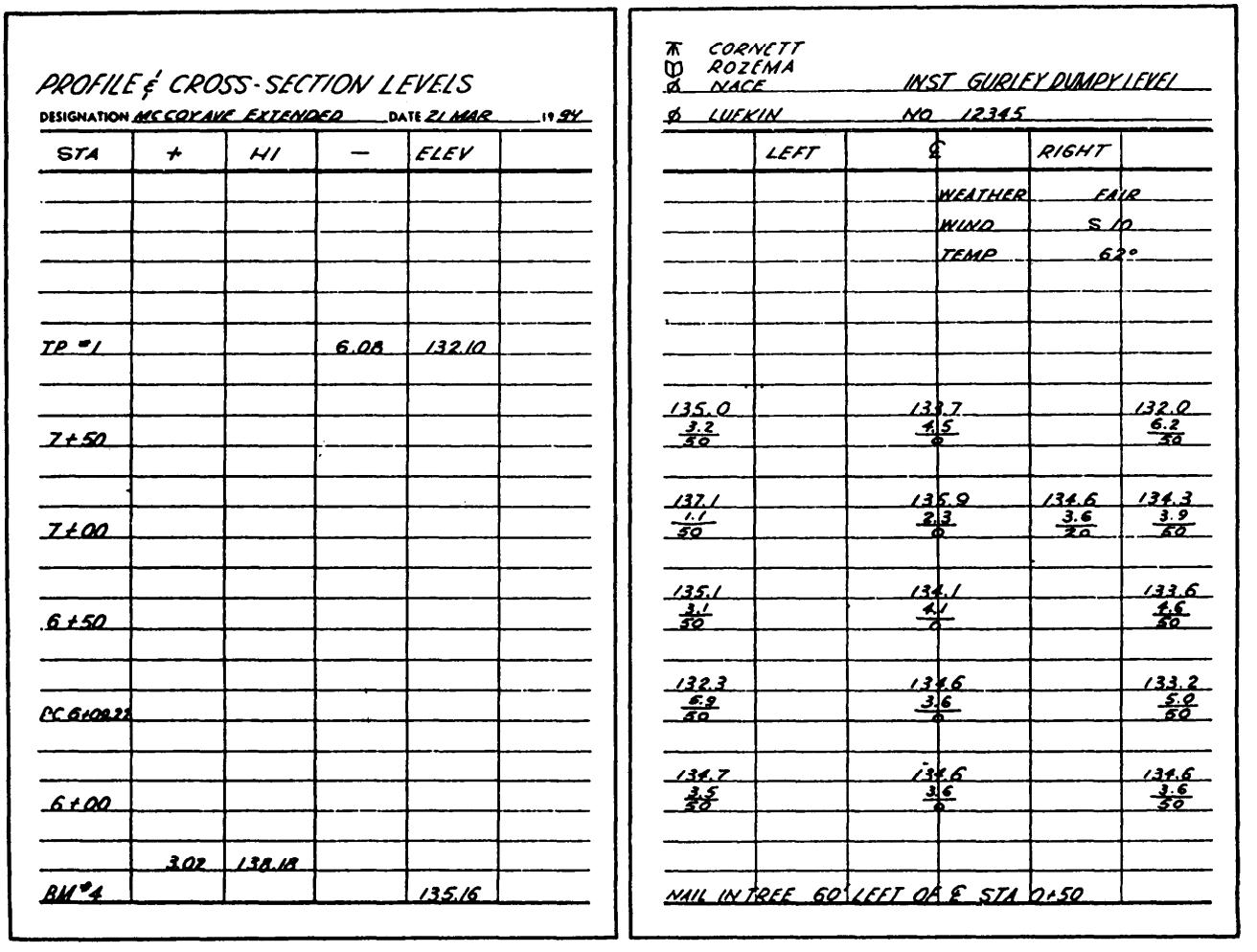


Figure AIII-11.—Horizontal curve layout.



PROFILE & CROSS-SECTION LEVELS

DESIGNATION McCOY AVE EXTENDED DATE 21 MAR 19 94

STA	+	HI	−	ELEV	
TP #1			6.08	132.10	
7+50					
7+00					
6+50					
PC 6+09.22					
6+00					
	3.02	138.18			
BM #1				135.16	

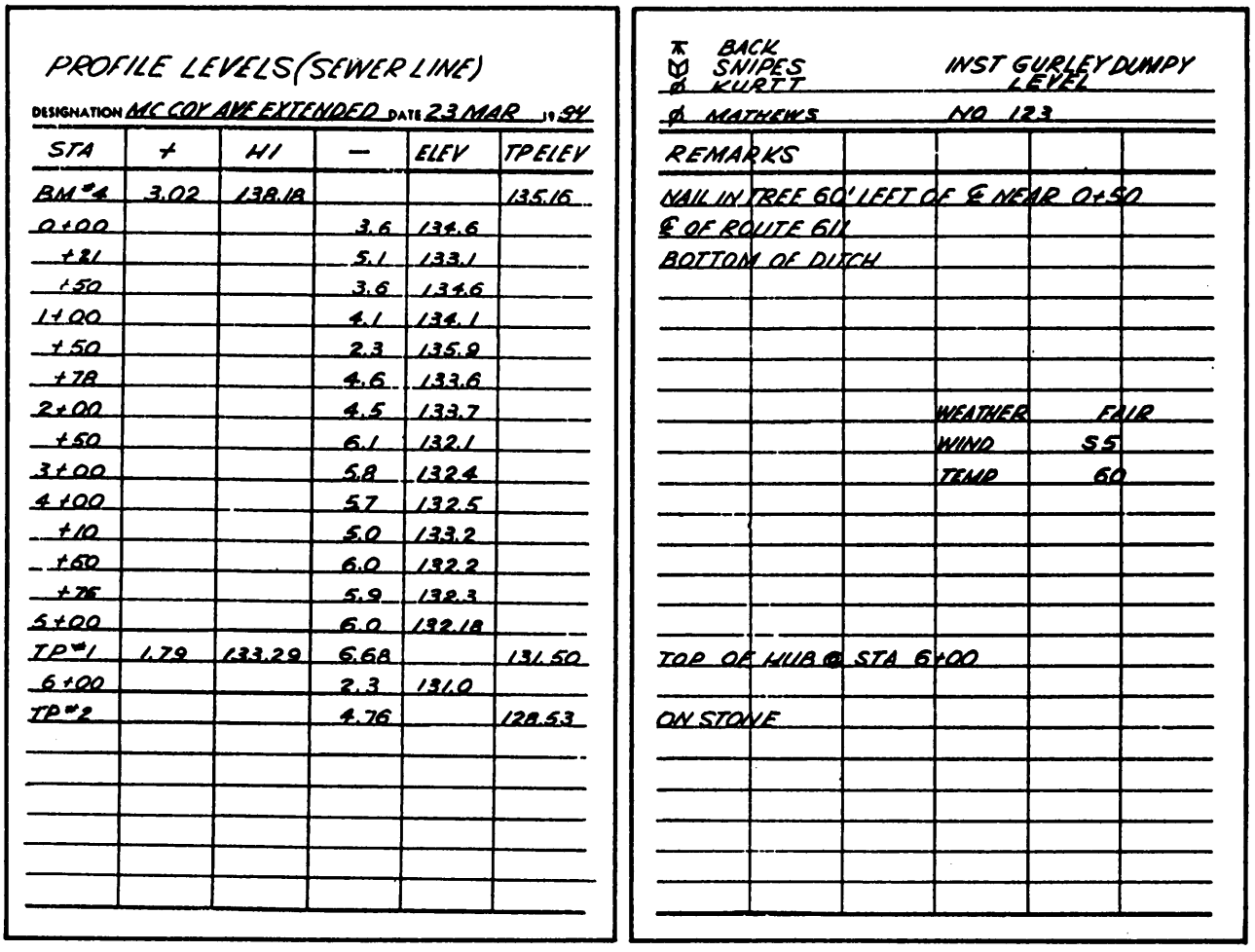
CORNETT
ROZEMA
NACE
LUFKIN

INST GURLEY DUMPY LEVEL
NO 12345

	LEFT	℄	RIGHT	
		WEATHER	FAIR	
		WIND	S 10	
		TEMP	62°	
135.0 / 3.2 / 50		133.7 / 1.5 / 0		132.0 / 6.2 / 50
137.1 / 1.1 / 50		135.9 / 2.3 / 0	134.6 / 3.6 / 20	134.3 / 3.9 / 50
135.1 / 3.1 / 50		134.1 / 4.1 / 0		133.6 / 4.6 / 50
132.3 / 6.9 / 50		134.6 / 3.6 / 0		133.2 / 5.0 / 50
134.7 / 3.5 / 50		134.6 / 3.6 / 0		134.6 / 3.6 / 50

NAIL IN TREE 60' LEFT OF ℄ STA 0+50

Figure AIII-12.—Profile and cross-section levels.



PROFILE LEVELS (SEWER LINE)

DESIGNATION MC COY AVE EXTENDED DATE 23 MAR 19 94

STA	+	HI	—	ELEV	TP ELEV
BM #1	3.02	138.18			135.16
0+00			3.6	134.6	
+81			5.1	133.1	
+50			3.6	134.6	
1+00			4.1	134.1	
+50			2.3	135.9	
+78			4.6	133.6	
2+00			4.5	133.7	
+50			6.1	132.1	
3+00			5.8	132.4	
4+00			5.7	132.5	
+10			5.0	133.2	
+60			6.0	132.2	
+75			5.9	132.3	
5+00			6.0	132.18	
TP #1	1.79	133.29	6.68		131.50
6+00			2.3	131.0	
TP #2			4.76		128.53

BACK SNIPES
KURTT
MATHEWS

INST GURLEY DUMPY LEVEL NO 123

REMARKS

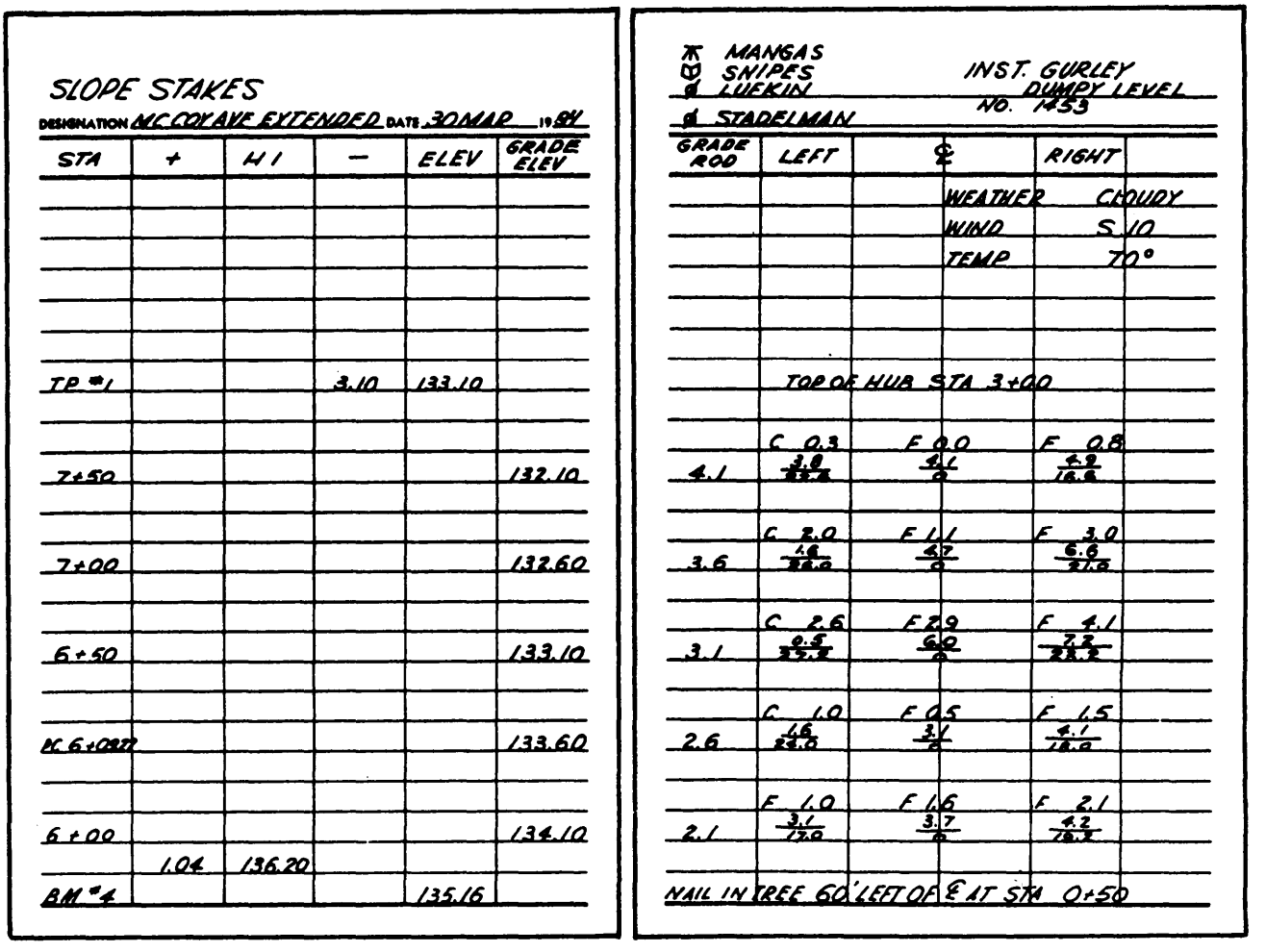
NAIL IN TREE 60' LEFT OF ℄ NEAR 0+50
℄ OF ROUTE 611
BOTTOM OF DITCH

WEATHER FAIR
WIND SS
TEMP 60

TOP OF HUB @ STA 6+00

ON STONE

Figure AIII-13.—Additional example of profile levels.



SLOPE STAKES

DESIGNATION McCOY AVE EXTENDED DATE 30 MAR 19 84

STA	+	H I	—	ELEV	GRADE ELEV
TP #1			3.10	133.10	
7+50					132.10
7+00					132.60
6+50					133.10
MC 6+087					133.60
6+00					134.10
	1.04	136.20			
BM #1				135.16	

TM MANGAS
SM SNIPES
LUEKIN
STADELMAN

INST. GURLEY DUMPY LEVEL NO. 1453

GRADE ROD	LEFT	℄	RIGHT
		WEATHER	CLOUDY
		WIND	S 10
		TEMP	70°
	TOP OF HUB STA 3+00		
4.1	C 0.3 3.8 / 23.8	F 0.0 4.1 / 0	F 0.8 4.9 / 16.6
3.6	C 2.0 4.6 / 26.0	F 1.1 4.7 / 0	F 3.0 6.6 / 27.0
3.1	C 2.6 0.5 / 25.5	F 2.9 6.0 / 0	F 4.1 7.2 / 28.5
2.6	C 1.0 4.6 / 23.0	F 0.5 3.1 / 0	F 1.5 4.1 / 18.0
2.1	F 1.0 3.1 / 12.0	F 1.6 3.7 / 0	F 2.1 4.2 / 16.9
NAIL IN TREE 60' LEFT OF ℄ AT STA 0+50			

Figure AIII-14.—Slope-stake notes.

BUILDING LAYOUT

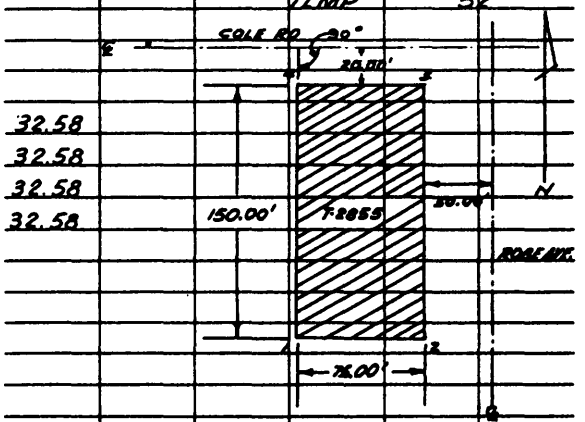
DESIGNATION BLDG T-2855 DATE 1 APR 19 84

STA	BS	HI	FS	ELEV	GRADE ROD
BM 18	5.22	35.22		30.00	
1			4.26	30.96	
2			4.14	31.08	
3			4.68	30.54	
4			4.52	30.70	
1					2.64
2					2.64
3					2.64
4					2.64

T SNIPES
SG TILKIN
Ø LUEKIN
Ø COWART

INST KEE LEVEL / KEE I'TRANSIT NO 451206/4219

BATTER ELEV	REMARKS
	WEATHER FAIR
	WIND S 8
	TEMP 52°
32.58	
32.58	
32.58	
32.58	



NOTE : BATTERBOARD ELEVATION 1.5' ABOVE HIGHEST CORNER.
BATTERBOARD ELEVATION IS TOP OF FOUNDATION.

Figure AIII-15.—Building layout.

PLANE TABLE MAPPING PROBLEM

DESIGNATION AREA K DATE 10 APR 19 94

STA	CORR H DIST	H SCALE	RI	V SCALE	PRODUCT ±
A					
1	625	100	6.25	55	+ 31.25
2	160	100	1.60	48	- 3.2
3	199	97	2.05	68	+ 36.9
4	368	98	3.75	62	+ 45.0
5	105	100	1.05	54	+ 4.2
6	425	100	4.25	47	- 12.8
7	240	98	2.45	37	- 31.8
8	255	100	2.55	50	0
9		100	3.65	52	
10		99	0.85	58	
11		99	4.55	61	
12		100	2.20	50	
13		97	2.85	33	
14		100	6.70	54	
15		99	3.35	40	
16		99	1.70	38	
17		100	5.10	47	
18		100	4.40	55	

T LOCKE
M SNIPES
S SMITH
J JONES

INST K&E ALIDADE NO 6666
WEATHER CLEAR
WIND N 10
TEMP 75°

RC	DE ±	HI	ELEV	REMARKS
	+ 4.3	116.7	112.4	ELEV STA A
- 4.6	+ 26.6		143.3	TOP OF SLOPE
- 2.8	- 6.0		110.7	BOTTOM OF SLOPE
- 8.4	+ 28.5		145.2	℄ ROAD
- 7.2	+ 37.8		154.5	℄ ROAD
- 3.9	+ 0.3		117.0	SPOT ELEV
- 4.4	- 17.2		99.5	SPOT ELEV
- 7.5	- 39.3		77.4	M.H.
- 5.4	- 5.4		111.3	POWER POLE
- 6.7				18" CULVERT
- 4.3				WATER VALVE
- 7.6				EDGE ROAD
- 3.1				EDGE ROAD
- 8.4				EDGE ROAD
- 5.2				COR PARK LOT
- 6.4				COR PARK LOT
- 4.1				EDGE ROAD
- 8.2				18" CULVERT
- 5.6				POWER POLE

Figure AIII-16.—Plane-table notes.

APPENDIX IV

OTHER USEFUL REFERENCES

NOTE: Listed in this Appendix are a few references that you may find useful when assigned to duty outside the Naval Construction Force. They are NOT required study for advancement. Following each reference is a brief description of its purpose.

Facilities Planning Criteria for Navy and Marine Shore Installations **(NAVFAC P-80)**

This publication provides planning criteria for determining the requirements for shore-based facilities needed to support Fleet and Marine Corps Operations. In addition, these criteria are used to evaluate the adequacy of existing facilities, to identify facility deficiencies or excesses, and to validate construction project submittals.

Facilities Projects Manual **(OPNAVINST 11010.20 SERIES)**

This instruction provides detailed guidance for the administration of facilities projects at naval shore activities. It includes definitions of the various typesof special projects and the preparation and submittal procedures for special projects.

Naval Mobile Construction Battalion Facilities **(NAVFAC P80.2)**

This publication is similar in purpose to NAVFAC P-80, described above; however, it is tailored specifically to facilities needed to support Naval Mobile Construction Battalion Operations.

Shore Facilites Planning Manual **(NAVFACINST 11010.44 SERIES)**

T'his instruction explains the process for the planning of shore facilities. It provides guidance on the preparation of Military Construction (MILCON) and Nonappropriated Funded (NAF) project documentation, and for the preparation of site approval documentation required for MILCON, NAF, and special projects.

APPENDIX V

UNIFIED SOIL CLASSIFICATION SYSTEM

The figure and tables in appendix V relate to identification and classification of soil.

Table AV-1 presents useful information concerning the Unified Soil Classification System.

Figure AV- 1 concerns the classification of soil after the soil has been visually identified as coarse grained, fine grained, or highly organic.

Table AV-2 shows soil characteristics pertinent to roads and airfields.

Table AV-3 shows soil characteristics pertinent to embankments and foundations.

ALL FOLDOUTS REMOVED
from APPENDIX V

APPENDIX VI

ANSWERS

NOTE: This appendix provides answers to the review questions found at the end of each chapter of this TRAMAN. When a question was drawn from a source other than this TRAMAN, the reference source is included with the answer.

Chapter 1

A1. Footing abutment, pile abutment, and concrete abutment.

A2. The numbers of rows of piles. A bent has one row of piles; a pier has two or more rows.

A3. Foundation bed, footing, and foundation wall.

A4. A sheet pile.

A5. A mole.

A6. The W12 x 50 wide flange shape. Because it has a greater cross-sectional area.

A7. The type of construction that uses masonry walls to support floor and roof loads.

A8. According to Steelworker 3 &2, NAVEDTRA 10653-G, page 12-10, girts are used primarily as attachment members for the metal siding.

Chapter 2

A1. The transmission system and the distribution system.

A2. The radial distribution system.

A3. To step down primary voltage to utilization level.

A4. On a crossarm or spool rack located below the primary mains.

A5. When they are shown to be more economical or when special circumstances warrant the use of concrete poles.

A6. Number size, type, voltage, and location.

A7. The level of underground water that has collected over an impervious stratum.

A8. Water quantity, reliability, and quality.

A9. NEVER. Water distribution and sewage collection piping must always be separated.

A10. To pump sewage from a lower level to a higher level because gravity flow is no longer possible or practical at the lower level.

Chapter 3

A1. (A) Traveled way, (B) shoulder, (C) crown, (D) base course, (E) subbase course, (F) surface or surface course.

A2. Superelevation.

A3. Final cross sections.

Chapter 4

A1. (A) Architectural, (B) civil (C) mechanical, (D) structural.

A2. D.

A3. The roles of the condenser and evaporators can be reversed so that the heat pump can be used for both heating and cooling.

A4. Temperature, humidity, and air motion. (Source: Utilitiesman 3, NAVEDTRA 12532, page 10-41.)

A5. Policy and Procedures for Project Drawing and Specification Preparation, MIL-HDBK-1006/1.

A6. Centimeter. (Source: MIL-HDBK-1006/1.)

A7. Vertical.

A8. The letter P. (Source: MIL-HDBK-1006/1.)

A9. Never.

A10. To make sure the drawing can be clearly reproduced.

Chapter 5

A1. NAFACENGCOM guide specifications.

A2. Specifications take precedence over drawings.

A3. 16.

A4. Division 2: Site Work

A5. Part 3: Execution.

A6. Seabee Planner's and Estimator Handbook, NAVFAC P-405.

A7. 94 cubic meters.

A8. 5 percent. (Source: Seabee Planner's and Estimator's Handbook, NAFAC P-405, appendix C.)

A9. Facilities Planning Guide, NATFAC P-437.

A10. Volume II, Part 3 (Assemblies).

Chapter 6

A1. The vertical axis.

A2. Three times.

A3. To make the line of sight parallel to the horizontal axis of the instrument so that the line of sight will generate a true horizontal plane when the instrument is rotated about the vertical axis.

A4. To enable you to use any point on the vertical cross hair when you are measuring angles or running lines.

A5. Only when a low degree of accuracy can be tolerated and an adjustment cannot be made immediately.

Chapter 7

A1. Barometric leveling and trigonometric leveling.

A2. (A) 398.303 meters, (B) –46.506 meters. (If your answer to Part A is incorrect, then you should review Engineering Aid 3, pages 12-18 and AIII-13.)

A3. (A) 0.08 feet, (B) no.

A4. (A) –0.21 feet, (B) +23.02 feet.

A5. 0 feet.

A6. 1/959 (or 1/1,000).

A7. N47°45´E.

A8. 8,520 square feet.

Chapter 8

A1. Topographic control is the establishment of the horizontal and vertical control points from which the location and elevation of all topographic details are determined.

A2. 0.05 distance in miles. No.

A3. (A) 243 feet, (B) +28.1 feet, (C) 202.4 feet.

A4. (A) 566 feet, (B) 327.3 feet.

A5. The vertical distance between adjacent contour lines.

A6. Either a summit or a depression.

Chapter 9

A1. Wingnut B. (Source: Engineering Aid 3, NAVEDTRA 10696.)

A2. Inside the triangle of error.

A3. Progression or plane-table traverse.

A4. Correct H-Dist = 365; Product = + 7.3; DE = +0.6; Elev = 117.3.

A5. For any given area distortion is nearly the same in all directions.

A6. 3MTV.

A7. 1,174 miles.

Chapter 10

A1. Reconnaissance, preliminary, and final-location survey phases.

A2. To make installation, inspection, and maintenance of the line easier and to lessen the requirement for tree trimming.

A3. The water remaining after absorption, evaporation, and transpiration.

A4. 95.92 feet.

A5. (A) 233.3 square feet, (B) 480.7 cubic yards.

A6. A distance at which the cost of haul equals the cost of excavation.

A7. (C) The degree of accuracy required.

A8. 25 feet.

A9. 0.27974.

A10. Interior angles.

Chapter 11

A1. Station at PC_1: 19 + 11.71

Station at PI_1: 23 + 84.28

Station at PCC: 27 + 68.85

Station at PI_2: 29 + 66.62

Station at PT_2: 31 + 43.85

A2. d_1 = 1052.1´, d_2 = 2°37.9´, d = 6°, C_1 = 31.13fi, C_2 = 43.84ft, C = 99.81 ft.

A3. 6 stations (600 feet).

A4. (A) 124.80 feet, (B) 128.00 feet, (C) 128.80 feet, (D) 128.25 feet, (E) Station 14 + 67, elevation on tune equals 129.0 feet.

A5. (A) 652.00 feet, (B) 624.00 feet, (C) 636.67 feet, (D) 643.20 feet, (E) Station 11 + 00, elevation = 652.00 feet. (The turning point is the high or low point on a vertical curve. When the tangent grades are equal, the high or low point will be at the center of the tune. When the tangent grades are both plus, the low point is at the PVC and the high point is at the PVT. When both tangent grades are negative, the high point is at the PVC and the low point is at the PVT. When unequal plus and minus tangent grades are encountered, the high or low point will fall on the side of the curve that has the flatter gradient.)

Chapter 12

A1. Electromagnetic EDMs and electro-optical EDMs.

A2. 729.35 meters.

A3. Electronic positioning systems.

A4. The lock mode.

Chapter 13

A1. To determine the moisture content at which the maximum density for a given compactive effort occurs.

A2. (A) Proctor, (B) 25.

A3. To ensure that densities obtained in the field conform to the project specification requirements.

A4. The bulk density can change due to varying temperature and humidity conditions.

A5. Shear.

A6. Type V (sulphate-resistant portland cement).

A7. The aggregate contains exessive organic material.

A8. Hairline cracking.

A9. Water that is in excess of the amount needed for a saturated, surface-dry condition.

A10. For improved watertightness and increased resistance to frost action.

A11. The chemical reaction between cement and water that causes a concrete to harden.

A12. When the test specimen breaks outside the middle third of span length by less than 5 percent.

A13. By heating, dissolution, and emulsifiication.

A14. The volubility test.

A15. A distillation test.

Chapter 14

A1. 75 man-days.

A2. Indirect labor.

A3. 61 percent. (Source: NMCB Operations Officer's Handbook, COMSECOND/COMTHIRDNCBINST 5200.2A, Section IV.)

A4. 150 man-days. (Source: NMCB Operations Officer's Handbook, COMSECOND/THIRDNCBINST 5200.2A, appendix I.)

A5. Commander, THIRD Naval Construction Brigade.

A6. So that you can (1) get all of the information needed for the job from the person requesting it and (2) pass this information on to the person to whom you are assigning the job.

Chapter 15

A1. 24.

A2. 0600.

A3. The angular distance of a celestial body measured north or south of the celestial equator along the hour circle of the body.

A4. Over the south celestial pole.

A5. N43°03´.

A6. S76°55´00.1"E.

A7. The calculation of the length of the sides can be cross-checked using different routes.

A8. A primary triangulation station is used as an instrument station and a sighted station. A secondary station is used only for sighting.

A9. 38°22´18.25".

Chapter 16

A1. 4.

A2. True.

A3. 4.

A4. (A) 21.18 ercent, (B) 74.25 percent, (C) 4.57 percent, (D) SP.

A5. (A) LL = 43, (B) PI = 18, (C) CL.

A6. 4.

Chapter 17

Al. (A) 1 1/2 inches, (B) 33.0 gallons, (C) 860 pounds, (D) 1,848 sacks, (E) 333.9 tons.

Chapter 18

A1. Lime.

A2. Clayey soils.

A3. Sieve analysis, Atterberg limits test, moisture-density test, and freeze-thaw test.

A4. A CBR mold. (Source: NAVFAC MO-330, chapter 5.)

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